KANSAS WATER QUALITY MONITORING AND ASSESSMENT STRATEGY

2019-2028

Kansas Department of Health and Environment
Bureau of Water
Watershed Planning, Monitoring, and Assessment Section

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EXECUTIVE SUMMARY

Water quality monitoring and assessment operations in Kansas are administered primarily by the Kansas Department of Health and Environment. The department maintains several ongoing programs that collectively fulfill the environmental surveillance and reporting requirements of the Clean Water Act and provide the technical data needed to identify and respond to existing and emerging water pollution problems. This report summarizes the current scope and developmental status of these programs and presents recommendations for improving monitoring and assessment operations in the state during the upcoming planning period, 2019-2028. Though the strategy is covering a ten year period, it will be reviewed and revisited in 2024 to reassess priority recommendations.

Overview of Water Quality Monitoring Programs

Departmental monitoring operations currently focus on the condition of the state's surface water resources and involve two different but complementary conceptual approaches. The first approach involves a targeted survey design that focuses on selected stream reaches, lakes, and wetlands that are routinely monitored. The second approach involves a probabilistic survey design that assesses randomly chosen representatives from a given class of water bodies (*e.g.*, wadeable streams, small lakes) and extrapolates the monitoring results to the entire population of water bodies in that class.

The targeted stream chemistry monitoring network consists of 327 sampling stations and generates physical, chemical, radiological, and microbiological data useful in the characterization of pollutant loadings from more than 97 percent of the state's contributing drainage area. Information derived from this network is applied in the development of total maximum daily loads (TMDLs) for water quality-limited streams and in the formulation of water quality-based permit limits for facilities discharging treated effluent to the waters of the state. Another targeted program, the stream biological monitoring program, evaluates the pollution-tolerance of benthic macroinvertebrate assemblages at approximately 180 locations in Kansas. Information from this program enhances the department's ability to detect water pollution problems, identify contaminants of concern, and develop defensible TMDLs and wastewater treatment plant permits.

The department also routinely surveys 175 publicly owned (or publicly accessible) lakes and wetlands. Physicochemical and biological data generated by this program are applied in the development of TMDLs and water quality-based permit limits, the resolution of toxic algal blooms and algal-related taste and odor problems, the characterization of lake trophic condition, and the tracking and prediction of long-term trends in surface water quality.

Working with other state and federal agencies, the department also collects and analyzes fish tissue samples from streams and lakes throughout Kansas. Targeted monitoring efforts are limited annually to about 40 water bodies, including heavily fished reservoirs and certain streams with known water quality problems and existing fish consumption advisories.

The department also maintains a compliance monitoring program for evaluating the performance of discharging wastewater treatment facilities within the state. Samples of treated effluent are collected from about 20 facilities in any given year and subsequently analyzed to assess

compliance with permit requirements. As needed, this program also conducts use attainability analyses (UAAs) to determine the classification status and attainable uses of individual waterbody segments receiving wastewater discharges.

The stream probabilistic monitoring network is predicated on a random, but spatially balanced, site selection process. Data on surface water chemistry, macroinvertebrate community composition, phytoplankton community composition, and in-stream physical habitat are obtained from 35 to 50 randomly selected sites annually, and a new set of sites is selected for monitoring each year. A similar approach is used to assess contaminant levels in fish inhabiting wadeable streams and small (but publicly managed) lakes. Fish tissue samples are additionally obtained annually from sites that contain edible fish of harvestable size. Data from the various probabilistic monitoring programs are applied by the department in statewide water quality assessments (discussed below) and in the screening of the entire state for water bodies warranting inclusion in targeted sampling activities.

The Harmful Algal Bloom Response program coordinates and performs monitoring at public lakes in response to complaints associated with blue-green algal blooms. Since 2010, the department has operated harmful algal bloom (HAB) monitoring in public recreational waters based solely on response. This first requires a request for KDHE to investigate a blue-green algae bloom due to visual indicators in the affected waterbody. KDHE then organizes sampling of the waterbody through the District Offices, and determines the level of toxins associated with each HAB event. If resources allow, KDHE will additionally determine the cell counts of cyanobacteria for the lakes sampled. Members of the department then follow protocols listed in the "Harmful Algal Bloom KDHE Agency Response Plan" to determine whether public advisories should be issued and the next course of action for sampling activities of the affected waterbody. The current HAB season extends from April to October, when lakes are most likely to be affected by HABs, and when members of the public are most likely to recreate in waterbodies. The number of lakes with harmful algal bloom advisories each year has increased recently with 26 and 32 lakes being affected in 2017 and 2018, respectively. Additionally the number of samples run each year has also increased, with an average of 207 samples per year in the time period from 2011-2018.

The Subwatershed Water Quality Monitoring Program was established in 2010 to monitor selected HUC12 "subwatersheds" within active Watershed Restoration and Protection Strategy (WRAPS) project areas. The selected subwatersheds are targeted by KDHE for total maximum daily load (TMDL) reduction and identified by WRAPS groups as high priority areas for implementation of WRAPS plans. A successful WRAPS plan includes both agricultural best management practices and other environmental improvement actions. Monitoring in the subwatersheds consists of sampling 10-15 sites for a five year period to establish baseline conditions and document initial improvement in water quality stemming from the implementation of WRAPS plans. The initial data collected during the first five year period will ultimately be compared to future monitoring results to document changes in water quality coinciding with WRAPS plan implementation.

The department also engages in a variety of short-term water quality investigations supportive of special regulatory initiatives or implemented in response to water quality emergencies such as contaminant spills, sewage bypasses, toxic algal blooms, or major fish kills. Additionally, the department works with other state and federal agencies and private organizations to support

volunteer water quality monitoring programs, largely through the provision of grants and technical expertise. Although these programs serve an important educational function, volunteer monitoring data are not currently applied by the department in a formal assessment or regulatory context owing to quality assurance limitations.

Overview of Water Quality Assessment Programs

An updated version of the Kansas Integrated Water Quality Assessment (IWQA) is published by the department every two years, pursuant to the reporting requirements of the federal Clean Water Act. Sections 305(b) and 314(a) of the Act require a biennial assessment of surface water quality conditions, whereas section 303(d) calls for the development and maintenance of a list of water bodies failing to meet established water quality standards. Such water bodies are regarded collectively as "impaired waters." States are required under the Clean Water Act to take actions that improve the condition of impaired waters. These actions often include the development and implementation of TMDLs, water quality-based permit requirements, and/or nonpoint source (NPS) pollution control measures. The IWQA also contains information on upcoming water quality planning, monitoring, permitting, and pollution abatement initiatives in Kansas.

Data applied in the 305(b) and 314(a) related assessments are derived from the previously described departmental monitoring programs. Assessment criteria vary among sampling locations depending on the designated uses of the monitored water bodies. Measured water quality conditions are compared with applicable numeric and narrative criteria set forth in the Kansas Surface Water Quality Standards or in federal guidance documents. Water bodies are classified by the department as fully supportive, partially supportive, or non-supportive of each designated use. The overall level of use support is calculated for the state's entire population of monitored streams, lakes, and wetlands and presented along with other relevant information in the IWQA.

Pursuant to section 303(d) of the Clean Water Act, the department maintains an inventory of water bodies needing additional work beyond existing controls to achieve or maintain water quality standards. As part of the 303(d) assessment, the department makes Integrated Reporting decisions for waters utilizing the five reporting categories provided by EPA guidance and interpreted by KDHE in the *Methodology for the Evaluation and Development of the Section 303(d) List of Impaired Water Bodies for Kansas*. Routinely monitored streams, lakes, and wetlands within Kansas provide most of the data applied in these Integrated Reporting categories and 303(d) based assessments. Supplemental sources of information include special water quality investigations, nonpoint source pollution surveys, drinking water source assessments, contaminant dilution calculations, trend analyses, predictive modeling, fish/shellfish consumption advisories, and information provided by other governmental agencies, academic institutions, and the general public. The state's 2018 303(d) list identifies 498 station/pollutant combinations of water quality impairments on lakes, wetlands, and stream systems (watersheds), encompassing 2,437 stream segment/pollutant and 111 lake/pollutant combinations. These impaired waters are needing the development of Total Maximum Daily Load plans (TMDLs) to address the offending pollutants. The 2018 list also identified 480 station/pollutant combinations of waters that were previously cited as impaired in prior lists but now meet water quality standards, with 19 of these being new in 2018.

The department routinely engages in a number of other water quality assessment activities. For example, prior to the issuance of any permit that authorizes a facility to discharge treated effluent to the waters of the state, the department must certify, in writing, that the planned release of effluent will not result in violations of the Kansas Surface Water Quality Standards, other applicable state laws, or any federally promulgated water quality standards. The facility's probable impact on the quality of the receiving surface water is evaluated by the department. Limits on the release of certain pollutants are incorporated into the facility's discharge permit based on the receiving surface water's designated uses, estimated assimilative capacity, measured background (upstream) pollutant concentrations, and the projected mean and maximum rates of effluent discharge. Currently, about 1,040 municipal, industrial, commercial, and federal facilities in Kansas are authorized by the department to release treated effluent to the waters of the state. The Watershed Planning, Monitoring, and Assessment Section completes approximately 210 water quality certifications each calendar year.

The department also prepares a report each year describing the state's nonpoint source pollution control objectives, projects implemented during the previous year in support of these objectives, and documented improvements in water quality attributable to nonpoint source pollution control efforts. A variety of additional reports, special publications, and peer-reviewed journal articles are generated by the department to disseminate water quality information to the broader scientific community, elected officials, regulated entities, and the general public.

Gaps in Monitoring and Assessment Programs

Declining allocations have led to the suspension of routine groundwater quality monitoring operations, a reduction in compliance monitoring activities, and to a marked decrease in the number of departmental employees engaged in surface water quality monitoring and assessment. Current initiatives, resources and funding levels preclude the collection of representative water quality data from the Missouri River. The department also lacks the resources needed to analyze water, sediment, and fish tissue samples for certain industrial contaminants, agricultural chemicals, pharmaceutical products and other substances believed to be widely present in the ambient environment. Additionally, the geometric-based monitoring program for the bacterium *Escherichia coli* has been discontinued due to the constraint on resources presented with intensive sampling. Budgetary enhancements needed to resume historical levels of groundwater and surface water quality monitoring are considered unlikely in the near future. The department has looked increasingly to fee funds and federal sources of funding for program support.

Recommended Improvements

The department will endeavor to implement a number of improvements in its surface water quality monitoring and assessment programs during the upcoming ten-year planning period.

Specifically, it will attempt to:

1) Enhance analytical methods for the Harmful Algal Bloom Program to reduce expenditures and staff time on conducting microscopic cell counts.
2) Enhance and amend the Subwatershed Monitoring Program to redefine priorities to meet current TMDL and WRAPS program needs, accommodate additional sites and utilize

alternative methods to capture flow hydrographs to reduce the burden on staff and resources.

3) Enhance the Stream Probabilistic program to benefit state monitoring priorities, while providing better utility and opportunities for other departmental programs. Report out on the first ten years of program accomplishments and implement enhancements, including dual purpose monitoring locations to benefit other monitoring programs were applicable.
4) Enhance the biological Aquatic Life Use Support Index to measure improvements in water quality directed at nutrient reduction and conduct a systematic mussel survey to evaluate how the biological community has changed over time.
5) Improve transparency of surface water quality data through the agency website and water quality atlas. Evaluate the interactive mapping platform and incorporate an automated system to query and display current readily available and quality assured data to assist staff, agency partners, and the public
6) Update the Kansas Surface Water Register and incorporate updates as part of the next water quality standards triennial review.
7) Enhance compliance monitoring to add capacity to the number of sites sampled and expand monitoring beyond the traditional sampling of major dischargers.
8) Evaluate water quality improvement after 50 years of the Clean Water Act and incorporate TMDL effectiveness monitoring by enhancing monitoring efforts within watersheds specifically slated for TMDL development and for evaluation of post implementation effectiveness, primarily by increasing sampling visits to existing stream monitoring locations and by establishing additional locations at the sub-watershed level.
9) Evaluate alternative water quality data management storage options and update technology to improve data management and retrieval functionality.
10) Resume stream bacteriological monitoring initiatives to evaluate TMDL implementation progress.
11) Provide additional monitoring and assessment training. Enhance cross training opportunities to train additional employees in specific sampling, analytical, and taxonomic skills to foster redundant capabilities in the event of retirement, injury, illness, or other factors leading to the loss or temporary absence of monitoring staff.
12) Assess feasibility for the analysis of additional parameters in monitoring programs through collaboration with the Kansas Health and Environmental Laboratory and EPA Region 7 Laboratory.
13) Improve capacity for data interpretation and analysis by ensuring programs function to accommodate additional data and outreach projects associated with each program's area of expertise.
14) Enhance communication and collaboration with the laboratory and to improve reporting limits for specific parameters of interest.
15) Initiate strategies to reinstate the groundwater quality monitoring program.
16) Collaborate with EPA Region 7 on strategies for Missouri River stream monitoring.

The successful implementation of these recommendations will depend, in large part, on the maintenance or extension of current levels of staff and funding for water quality surveillance and reporting activities.

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INTRODUCTION

The Clean Water Act provides the overarching federal mandate and statutory context for state water quality monitoring and assessment programs. Pursuant to this law, all states are required to monitor the physical, chemical, and biological condition of their surface water resources and strongly encouraged to monitor groundwater quality. States also are required to update water quality information annually, to comprehensively report on water quality conditions on a biennial basis, to develop and maintain a list and priority ranking of water quality-limited surface waters, and to report each year on improvements in water quality resulting from nonpoint source pollution control efforts. The Clean Water Act prohibits the transfer of certain federal funds to any state failing to comply with these basic monitoring and reporting requirements (Appendix A).

In Kansas, water quality monitoring and assessment responsibilities rest primarily with the Kansas Department of Health and Environment (KDHE). The KDHE surface water quality monitoring programs are administered in the Watershed Planning, Monitoring, and Assessment Section within the Bureau of Water. State law compels the department to "investigate and report upon all matters relating to water supply and sewerage and the pollution of the waters of the state" (Kansas Statutes Annotated (K.S.A.) 65-170). Waters of the state are legally defined as "all streams and springs and all bodies of surface and subsurface water within the boundaries of the state" (K.S.A. 65-161(a)). Water pollution is defined, in part, as "contamination or other alteration of the physical, chemical or biological properties of any waters of the state...likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, or to the plant, animal or aquatic life of the state or to other designated uses" (K.S.A. 65-171d(c)).

This report evaluates the current status of water quality monitoring and assessment programs administered by KDHE and presents recommendations for improving these programs during the upcoming planning period, 2019-2028. Administrative and environmental benefits potentially derivable from the adoption of these recommendations include, but are not necessarily limited to, an enhanced departmental eligibility for federal funds, improved interagency collaboration, more cost effective scrutiny of natural resource conditions, and more expeditious targeting, prioritization, and resolution of water quality problems. In developing this report, KDHE has considered and incorporated the most recent federal guidance for state water quality monitoring and assessment programs (EPA 2003a).

The remainder of this document is presented in three major sections. The first provides a general overview of the state's surface water and groundwater resources. The second describes water quality monitoring and assessment programs currently administered by KDHE in terms of overall programmatic objectives, monitoring network design, core and supplemental water quality parameters, quality assurance features, requirements for data management, analysis and reporting, and administrative mechanisms for program evaluation and infrastructure planning. The final section of this report discusses preferred options for improving the department's water quality monitoring and assessment programs during the upcoming ten-year planning period.

KANSAS WATER RESOURCES

Statewide Water Budget

More than 98 percent of all water entering Kansas arrives in the form of precipitation. Although the total amount of precipitation varies from year to year, the running average computed over several decades remains nearly constant (Sophocleous 1998). Annual precipitation across the state averages 27 inches (69 cm) but ranges geographically from about 15 inches (38 cm) along the Colorado border to more than 40 inches (102 cm) in several southeastern counties (Goodin *et al.* 1995). Evapotranspiration returns about 86 percent of the state's precipitation back to the atmosphere, with most of the remainder entering streams as surface runoff (10 percent) or groundwater aquifers as natural recharge (3 percent). Streams flowing into Kansas from Colorado and Nebraska provide a statewide annual rainfall equivalent of less than 0.4 inches (1.0 cm), whereas streams flowing from Kansas into Missouri and Oklahoma export a rainfall equivalent of nearly 3 inches (7.6 cm). In years of average flow, the Missouri River carries an additional 32 million acre-feet (40 billion m^3) of water, or a statewide rainfall equivalent of 7.3 inches (18.5 cm), past the northeastern border of Kansas into western Missouri (Sophocleous and Wilson 2000).

Kansans divert approximately 6.8 million acre-feet (8.4 billion m^3) of water per year, on average. Groundwater diversions comprise about 72 percent of this total and are dominated strongly by irrigation withdrawals. Surface water diversions account for the remaining 28 percent and are dominated by cooling water withdrawals for electrical power generation (Sophocleous 1998; Sophocleous and Wilson 2000). Water usage varies from year to year depending on weather conditions, market and regulatory forces, and other factors. The following table itemizes water usage in Kansas during calendar year 2015 based on the most recently compiled information.

Table 1. Estimated water withdrawals in Kansas during calendar year 2015 by water use category (from Water Use Data for Kansas, https://waterdata.usgs.gov/ks/nwis/water_use). Values are expressed in Thousand acre/feet. No data were available for 2015 commercial use.

Water Source	**Water Use Category**									
	Public	Domestic	Commercial	Irrigation	Livestock	Aquaculture	Industrial	Mining	Thermoeletric	***Total***
Surface Water	393	0	-	136	23	4	9	1	906	1,472
Ground-water	153	20	-	2,866	94	4	34	6	9	3,185
Total	547	20	-	3,002	116	7	43	7	915	4,657

Surface Waters

Streams and springs

Kansas surface water quality regulations (K.A.R. 28-16-28b *et seq.*) define streams as "rivers, creeks, brooks, sloughs, draws, arroyos, canals, springs, seeps, and cavern streams, and any alluvial aquifers associated with these surface waters...." The stream network within the state

covered by the National Hydrographic Database (NHD) at a map scale of 1:24,000, indicates that the network has an extent of 183,266 stream miles. Perennial streams make up 16.7% or 30,632 miles of that universe. Ephemeral streams make up 0.17% or 313 miles and intermittent streams comprise the balance of 152,321 miles. Average annual runoff ranges from less than 0.1 inch (0.26 cm) in some western counties to 10 inches (27 cm) in extreme eastern Kansas (Wetter 1987); consequently, perennial streams are much more prevalent in the eastern half of the state (Figure 1). Throughout much of western Kansas, intensive irrigation has contributed to a progressive lowering of the groundwater table and a concomitant decline in stream flow and perennial stream mileage (*e.g.*, Jordan 1982; Cross *et al.*1985; Angelo 1994; Schloss *et al.* 2000; Juracek and Eng 2017). The Kansas Surface Water Register lists nearly 30,000 miles (48,000 km) of streams as classified waters subject to the application of numeric water quality criteria (KDHE 2013a). Legislation enacted in 2001 (K.S.A. 82a-2001 *et seq.*) has shifted regulatory focus away from ephemeral streams that only flow in response to rainfall. (Perry *et al.* 2004).

Springs comprise an important category of flowing waters, often supporting unique assemblages of plants and animals, sustaining stream flow during periods of limited precipitation, and serving as sources of water for communities and farmsteads. For the purposes of this report, springs are defined as "places where [groundwater] flows naturally from the earth into a body of surface water or onto the land surface, at a rate sufficient to form a current" (Buchanan *et al.* 1998). Sawin *et al*. (2002) have compiled water quality data and other descriptive information for 249 "significant and representative" Kansas springs with flows ranging from less than 1.0 to 1,800 gpm (< 5 to 9,800 m^3 day^{-1}). To date, property access limitations and other factors have precluded a more comprehensive inventory of springs in Kansas.

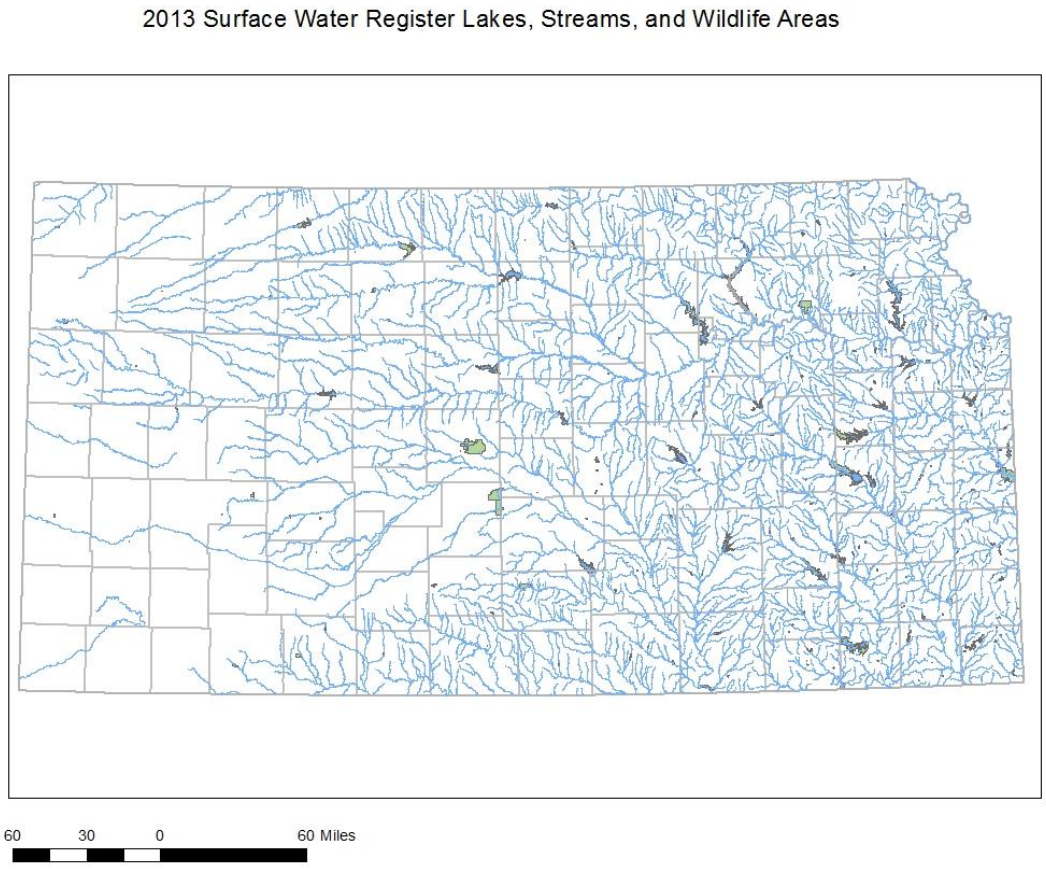

Figure 1. Major classified streams, lakes, and wetland in Kansas (KDHE, 2013)

Lakes and reservoirs

Kansas water quality standard regulations (K.A.R. 28-16-28b et seq.) define lakes as all "oxbow lakes and other natural lakes and man-made reservoirs, lakes, and ponds." Although natural lakes are relatively uncommon in Kansas, the state's total number of dams (registered and unregistered) and associated impoundments were estimated conservatively at 120,000 twenty-five years ago (KSBA 1992). This figure is dominated overwhelmingly by water bodies smaller than two acres (0.8 ha) and includes privately owned farm ponds and other smaller impoundments. According to the National Inventory of Dams (USACE 2005), Kansas contains approximately 5,900 larger earthen dams and associated impoundments, most located in the eastern third of the state. A more recent estimate counts over 240,000 small impoundments in the state (Callihan 2013). Twenty-nine reservoirs in Kansas exceed one square mile (2.6 km^2) in surface area and 32 feet (~10 meters) in maximum depth. Many of the state's larger reservoirs were developed originally for a combination of flood control, water supply, and recreational purposes, and nearly 85 are utilized currently as public drinking water sources. The majority of these reservoirs were developed 40 to 50 years ago, and several have experienced a significant decline in water storage capacity as a result of sediment accumulation (KWA 2010). The Kansas Surface Water Register currently

identifies 326 classified (publicly owned or publicly accessible) lakes with a combined surface area of about 190,000 acres (76,900 ha) (KDHE 2013, 2018a).

Wetlands

The term "wetlands" is defined by the Kansas Water Quality Standards (K.A.R. 28-16-28b et seq.) as "including swamps, marshes, bogs, and similar areas that are inundated or saturated by surface water or groundwater at a frequency and a duration that are sufficient to support, and under normal circumstances that do support, a prevalence of vegetation typically adapted for life in saturated soil conditions". Based on a somewhat less restrictive definition considering hydrological, soil, and/or biological criteria, the United States Fish and Wildlife Service has estimated the total wetland acreage for the state at 435,400 acres (176,200 ha) or approximately one-half the estimated pre-settlement coverage of 841,000 acres (340,400 ha) (Dahl 1990). Despite this historical loss of wetland resources, the state continues to maintain a number of major wetland complexes of regional and even international importance. The largest include Cheyenne Bottoms, a 14,000 acre (5,700 ha) freshwater marsh in Barton County, and the Quivira Big and Little Salt Marshes, covering a combined area of about 22,000 acres (8,900 ha) in neighboring Stafford, Rice, and Reno counties. These water bodies and several other major wetlands in Kansas are critical stopover points for migratory waterfowl and attract thousands of tourists each year (*e.g.*, Zimmerman 1990). The Kansas Surface Water Register currently identifies 35 classified (publicly owned or publicly accessible) wetlands with a combined surface area of about 56,000 acres (22,700 ha) (Carney 2002; KDHE 2013, 2018a).

Groundwater

Kansas regulations broadly define groundwater as "water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers or the soil profile" (K.A.R. 28-16-28b *et seq*.). Although the state has no formal groundwater quality standards, application of the groundwater recharge use to many classified streams is intended to prevent "statistically significant increase[s] in the concentration of any chemical or radiological contaminant or infectious microorganism in groundwater resulting from surface water infiltration or injection" (K.A.R. 28-26-28d(b)(5) and 28-16-28e(c)(5)). Groundwater resources are extensive in the western two-thirds of the state but less common and more localized in the eastern third (Figure 2). This disparity has contributed to a greater agricultural utilization and dependence on irrigation in western Kansas. Much of this region has experienced a significant decline in groundwater levels since the advent of center pivot irrigation in the late 1950s and early 1960s (*e.g.*, Jordan 1982; Cross *et al.*1985; Schloss *et al.* 2000). The total amount of freshwater storage in the state's major aquifers has been estimated at 590 million acre-feet (730 billion m^3), more than 90 percent of which is held in the High Plains/Great Plains aquifer complex of western and central Kansas (Hansen 1991).

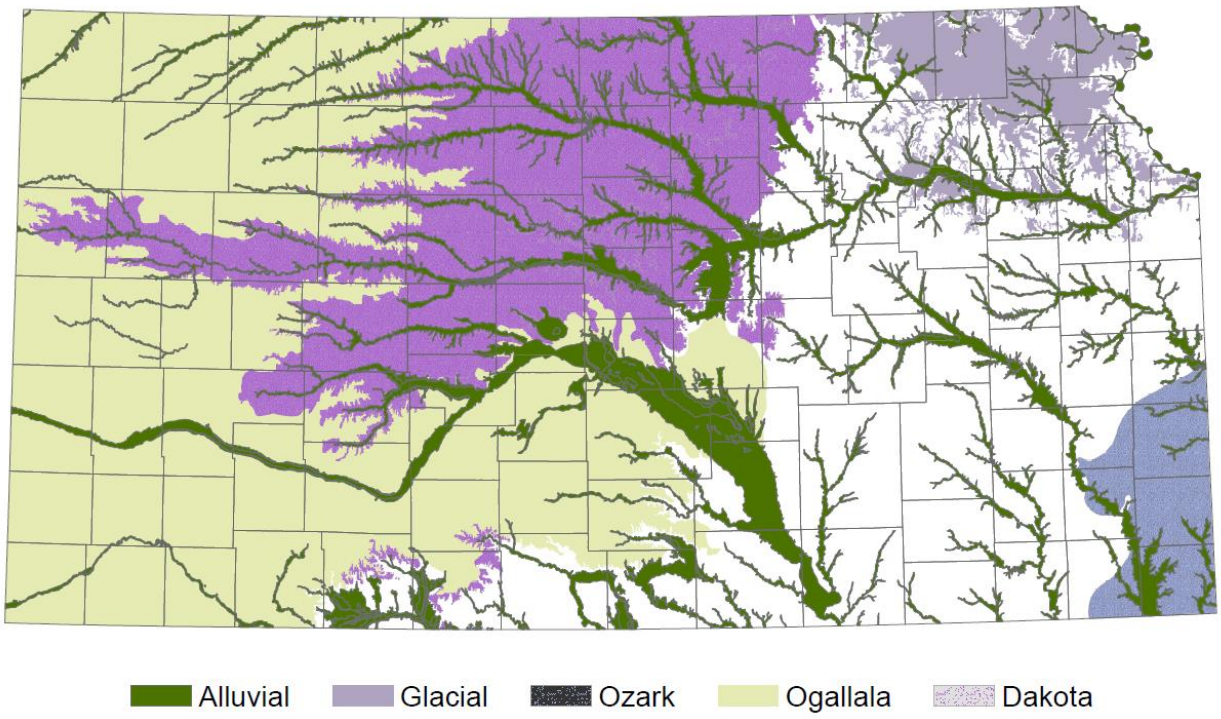

Figure 2. Major groundwater aquifers in KS (KGS, 2012)

STATUS OF KANSAS WATER QUALITY MONITORING AND ASSESSMENT PROGRAMS

Allocation of Duties

Water quality monitoring and assessment programs within KDHE are administered by the Division of Environment's Bureau of Water (BOW), with analytical support from the Kansas Health and Environmental Laboratories, computer programming and networking assistance from the Office of Information Technology, and consultative input from the Division of Health. The department also works cooperatively with various other agencies and organizations in the acquisition and interpretation of water quality data (discussed below). Routine monitoring operations are implemented by the BOW Watershed, Planning, Monitoring and Assessment Section, which maintains offices in downtown Topeka and employs 18 full-time staff members. Six district offices are maintained by the Bureau of Environmental Field Services (BEFS), and the offices located in Dodge City and Hays assist with the collection of water quality samples from sites in far western Kansas. The district offices work cooperatively with the Watershed Planning, Monitoring, and Assessment Section in the planning and performance of special water quality investigations, such as those occurring in the aftermath of major pollutant spills, toxic algal blooms, and fish kills.

Assessment duties associated with the development of the 305(b)-related portion of the IWQA are implemented by the BOW Watershed Planning, Monitoring and Assessment Section. The Assessment and Information Unit within the section is responsible for coordinating this effort, editing the text portion of the document, performing the 305(b) assessment for streams, and assisting with water quality violation reports for 303(d) assessments. The duties associated with the review and revision of the Kansas list of water quality-limited surface waters (*i.e.*, 303(d) list) and development of total maximum daily loads (TMDLs) are implemented by the Planning and Standards Unit within the section with input from other work units within the section. The Planning and Standards Unit is responsible for formulating the 303(d) list, assigning Integrated Reporting categories and priority rankings to listed surface waters, and developing TMDLs for these waters. The Monitoring and Analysis Unit assesses lakes and wetlands, which supports both 305(b) and 303(d) reporting needs and state priorities. The Bureau of Environmental Field Services (BEFS) Watershed Management Section assists with the evaluation of improvements in water quality resulting from the implementation of nonpoint source (NPS) pollution control programs.

Overview of Current Monitoring Operations

The Division of Environment traditionally has endeavored to maintain a comprehensive water quality monitoring program addressing the physicochemical and biological properties of all waters of the state. However, budgetary shortfalls in past years led to the indefinite suspension of routine groundwater quality monitoring operations (discussed below) in 2002. Divisional monitoring efforts now focus almost exclusively on the major inland surface water categories: streams, lakes, and wetlands.

The following paragraphs briefly describe the department's major water quality monitoring programs as well as cooperative monitoring efforts involving other governmental agencies,

academic institutions, and private organizations. For additional information on the developmental history and current status of these monitoring programs, the reader is referred to the applicable quality assurance management plans (QMPs) and standard operating procedures (SOPs) posted on the departmental quality assurance website (http://www.kdheks.gov/environment/qmp/qmp.htm).

Monitoring Goals and Objectives

The Kansas Department of Health and Environment relies on timely, accurate, and properly interpreted water quality data to guide the efforts of its various water pollution control programs and, ultimately, to protect and restore the physical, chemical, and biological integrity of the waters of the state. Although each monitoring program is designed around its own unique set of objectives (as set forth in a written QMP), essentially all monitoring programs lend themselves to the performance of the following tasks:

(1) fulfilling the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1), 303(d), 305(b), 314(a), and 319(h) of the Clean Water Act;

(2) evaluating compliance with the provisions of the Kansas Surface Water Quality Standards (K.A.R. 28-16-28b through 28-16-28g *et seq.*);

(3) identifying point and nonpoint sources of pollution contributing most significantly to documented water use impairments;

(4) documenting spatial and temporal trends in water quality resulting from changes in prevailing climatological conditions, land use/land cover, natural resource management practices, wastewater treatment plant operations, and other factors;

(5) developing scientifically defensible environmental standards, wastewater treatment plant permits, and waterbody-specific (or watershed-specific) pollution control plans; and

(6) evaluating the effectiveness of pollution control efforts and waterbody remediation and restoration initiatives implemented by the department and other natural resource agencies.

Stream Chemistry Monitoring Program

The stream chemistry monitoring program is the largest and longest running environmental monitoring operation administered by the BOW Watershed Planning, Monitoring and Assessment Section. Water samples are collected from all major river basins and physiographic regions throughout Kansas and analyzed for a large suite of physical, organic, inorganic, bacteriological and some cases, radionuclide parameters (Appendix B). The program database currently comprises over 2.8 million records from over 57,000 sampling events (1967-2018), representing nearly 400 active and inactive monitoring locations and approximately 125 different analytical parameters. Some records in the database date to the late 1960s, and several monitoring sites have a continuous period-of-record extending from that time to the present (KDHE 2018a).

Currently, the stream chemistry sampling network is comprised of 327 monitoring sites spanning

all the major river basins and physiographic regions of Kansas (Figure 3). Annually, 160 permanent sites are visited by staff on a quarterly basis, whereas the remaining 167 rotational sites are monitored using a four-year rotational approach; *i.e.*, samples are collected quarterly from approximately 25 percent of these sites each year. Sampling stations have been chosen to represent water quality conditions in specifically targeted watersheds or stream reaches. For example, some sites reflect water quality conditions in streams as they enter or exit Kansas, others represent conditions above or below major discharging facilities, urban areas, or reservoirs, and still others reflect water quality conditions in predominantly rural watersheds. Several "least impacted" reference streams have been included in the network to gain a better understanding of baseline water quality conditions in the various ecoregions of Kansas (*cf.*, Chapman *et al.* 2001; Angelo *et al.* 2010). Stream reaches hosting monitoring sites range in size from first to eighth order on the Strahler scale (Strahler 1957). As currently configured, the network provides water quality information useful in the characterization of pollutant loadings from more than 97 percent of the state's contributing drainage area. Many monitoring sites are located near the lower terminus of eight-digit hydrological unit code (HUC) watersheds and play an important role in the development and refinement of TMDLs for 303(d)-listed streams.

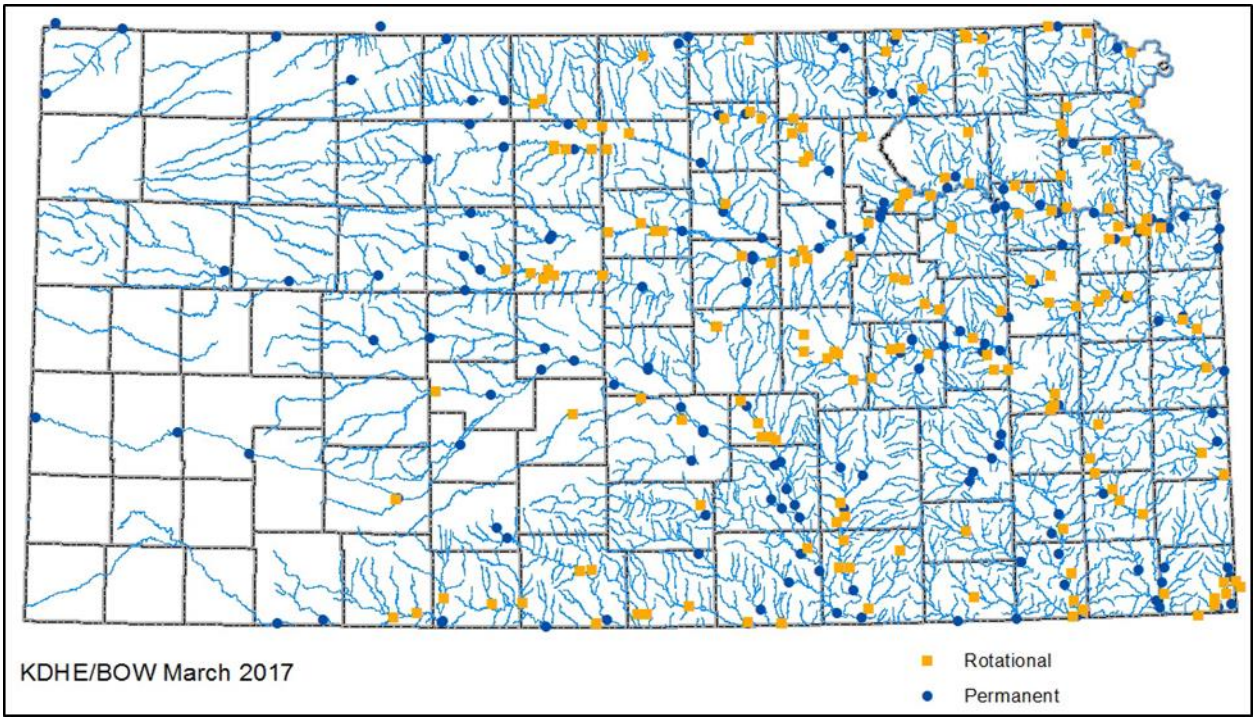

Figure 3. Current distribution of permanent and rotational stream chemistry monitoring stations.

Stream Biological Monitoring Program

This program examines the structural attributes of aquatic macroinvertebrate assemblages and utilizes this information to provide a more refined picture of the ecological status of streams in Kansas. Unlike water chemistry measurements alone, which reflect conditions occurring at the moment of sample collection, biological monitoring provides an integrated measure of environmental conditions over time frames ranging from weeks to years, depending on the biological assemblage of interest. The KDHE aquatic macroinvertebrate database currently contains more than 90,000 high resolution (predominantly genus/species level) records from over 2,200 separate samples (1980-2018). A reference collection of invertebrates is maintained by program staff which contains about 450 taxa of various aquatic and semiaquatic insects, mollusks, crustaceans, and oligochaetes.

The program's routine sampling activities are conducted in support of CWA section 303(d) monitoring and reporting requirements and incorporates a targeted monitoring strategy comparable to that of the stream chemistry monitoring program (KDHE 2012). Since its beginnings in the late 1970s, the program has collected macroinvertebrate samples and conducted freshwater mussel surveys at 225 sites throughout the state. Currently, sampling activities are conducted at approximately 40-60 sites each year depending on prevailing flow conditions. About 45 long-term core network stations, located primarily in the mid to lower watersheds of major rivers and streams, are sampled every year if conditions allow. Additional sites are visited each year as dictated by TMDL development needs, special studies, pollutant spill investigations, or other regulatory considerations. Routine sample collection activities are conducted in the summer and early fall during stable baseflow conditions as a variance control and to minimize the effects of seasonal bias in the resulting data. Sample collection, processing (e.g. specimen identifications), data management, and data interpretation are performed by program staff.

Lake and Wetland Monitoring Program

The lake and wetland monitoring program surveys water quality conditions in publicly owned and publicly accessible lakes and wetlands throughout Kansas. Individual water bodies are visited by staff on a 3–6 year rotational schedule, and field measurements and subsequent laboratory analyses provide data on a large suite of physical, organic, inorganic, and biological (phytoplankton, macrophyte) parameters (Appendix B). The program's primary database now contains more than 300,000 analytical records representing more than 300 water bodies. Watersheds associated with many of these monitored lakes and wetlands are periodically surveyed with respect to prevailing land use/land cover and the location and size of any discrete pollutant sources (wastewater treatment plants, feedlots, etc.). Macrophyte community composition and areal macrophyte coverage also are evaluated in selected water bodies smaller than 250 acres (~100 ha). Information derived from these ancillary activities improves the department's ability to estimate contaminant fluxes, characterize lake trophic conditions, predict future changes in these conditions, and assess the need for regulatory intervention (KDHE 2014a).

Water quality information currently is obtained from 175 lakes and wetlands distributed

throughout the state (Figure 4). These include all 24 federal reservoirs, most state-administered fishing lakes (those retaining open water in most years), various other state, county, or locally owned lakes, several privately owned but publicly accessible lakes, and seven state or federally owned marshes. Approximately 120 additional intermittent or very small systems are assessed using nutrient and chlorophyll-*a* data only. This allows for 15-20 more lakes per year to receive an assessment without overburdening the Kansas Health and Environment Laboratory's sample capacity. Because few lentic water bodies in Kansas are naturally occurring, an effort has been made to identify reservoirs in least disturbed watersheds to serve the function of reference ecosystems (Carney 1989–2012, 2002; Dodds *et al.* 2006). This program routinely shares a large amount of data and expertise with other agencies and organizations involved in lake and wetland management, environmental restoration, water quality monitoring, and environmental education. Additional collaborative efforts have addressed the abatement of toxic algal blooms and taste/odor problems in public drinking water supply reservoirs (Pope *et al.* 1985; Arruda and Fromm 1989; Carney 1989–2012, 1993a–b, 1994, 1996, 1998a–c).

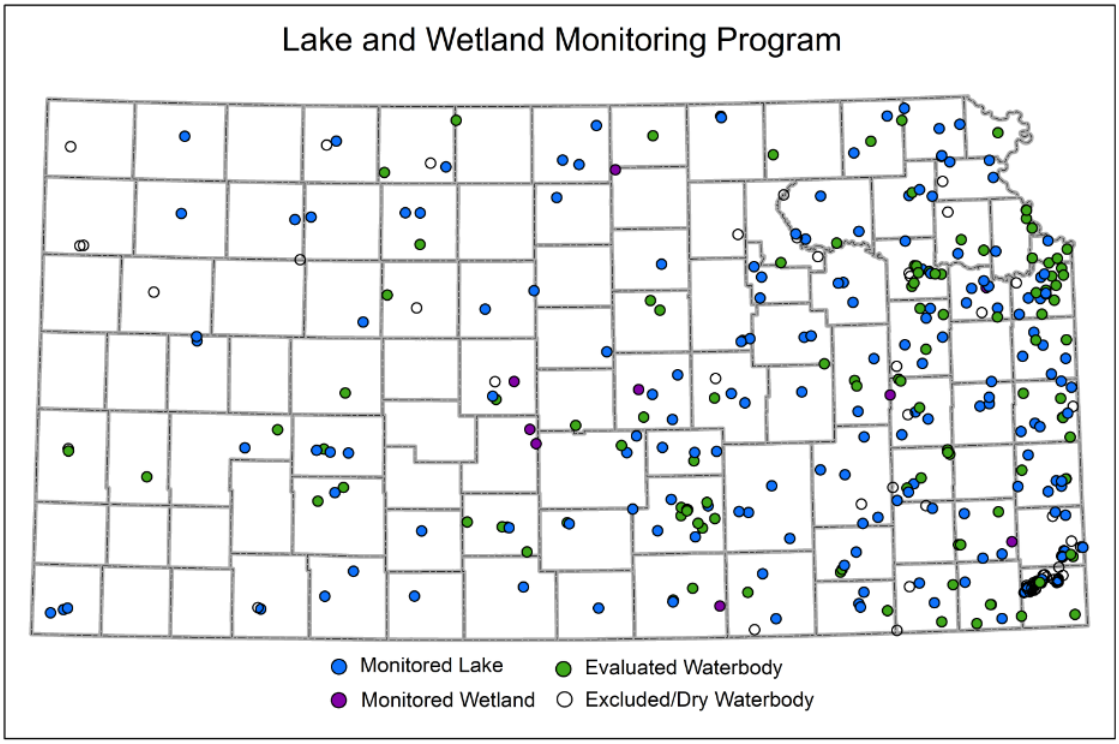

Figure 4. Lake and Wetland Monitoring program sampling network.

Fish Tissue Contaminant Monitoring Program

This program provides information on contaminant levels in the tissues of fish from Kansas' streams, rivers, and reservoirs. The program's database currently contains over 25,000 sample constituent records, which were generated from fish samples collected at more than 400 locations over the course of nearly 40 years. Early screening operations in the late 1970s and early 1980s analyzed bottom-feeding fish for the presence of about 200 individual synthetic contaminants

and toxic metals, of which more than 80 were detected (KDHE 1987, 1988a–b, 2013b; Cringan 1989, 1991) (Appendix B). Currently, priority pollutants monitored by the program include mercury, a few persistent organochlorine pesticides, and polychlorinated biphenyls (PCBs). Occasionally special circumstances may require the analysis of fish for the presence of other environmental toxicants (*e.g*. microcystin toxins).

On an annual basis the program currently collects tissue samples from 200-300 individual fish captured from 40+ monitoring sites, which are analyzed for mercury content by U.S. EPA's Region 7 laboratory in Kansas City, Missouri. Organic contaminant concentrations (*e.g*. pesticides and PCBs) in fish are evaluated at 5-10 monitoring stations per year using multi-fish composited whole-body or fillet samples that are analyzed by contracting laboratories. Sample site selection for both mercury and organic contaminants is based on a combination of targeted long-term and, targeted screening site as well as, probabilistic screening sampling designs in collaboration with the Stream Probabilistic Monitoring Program. The resources allocated to each type of sampling are flexible and may be adjusted according to the prevailing concerns of the public, agency priorities or previous screening results.

Data generated by the program are utilized to: 1) track the environmental fate of legacy pollutants; 2) identify specific lakes, streams, river reaches, and/or geographic regions containing types of fish that contain concentrations of environmental contaminants that may be of human health significance; 3) conduct assessments of the health risks associated with consuming contaminated fish; 4) support waterbody-specific and statewide fish consumption advisories; and 5) conduct special studies addressing priority public health concerns or questions of scientific significance.

Annual fish tissue consumption advisories serve as the primary public deliverable for the program, which are jointly released with the Kansas Department of Wildlife, Parks, and Tourism (KDWPT). KDHE program staff evaluate the fish contaminant data using U.S. EPA risk assessment methods to determine the need for issuing, rescinding, or modifying fish consumption advisories. The annual consumption advisories are issued in early January of each year through an official KDHE press release and published within KDWPT's fishing regulations guide booklet, which is available wherever fishing licenses are sold.

Stream Probabilistic Monitoring Program

Probabilistic sampling may be used to obtain representative data on the condition of a given class of natural resources. It differs from conventional sampling in that (a) monitoring stations are a randomly selected subset of the resource as a whole, and (b) an emphasis is placed on the assessment of the total resource rather than the individual monitoring locations. Until 2005, water quality monitoring programs implemented by KDHE employed traditional targeted network designs, which establish sites in a deliberate and strategic manner. Targeted designs are of critical importance in determining site- and watershed-specific water quality conditions. However, funding realities generally limit the number of targeted sites that can be sampled on an ongoing basis. Given these considerations, the department recommended the initiation of a probabilistic stream sampling program in the 2006-2010 five-year monitoring and assessment strategy (KDHE

2005b).

In 2004, KDHE participated in the National Wadeable Streams Assessment and gained a familiarity with the application of probabilistic sampling designs and associated field methods (EPA 2004). In 2005, the availability of supplemental monitoring funds under section 106(b) of the Clean Water Act provided an opportunity to: (1) develop a quality assurance management plan and accompanying set of standard operating procedures for a similar statewide probabilistic program (KDHE 2007); (2) hire and train two environmental scientists to assist with the implementation of field and taxonomic duties; (3) develop a list of randomly selected (candidate) stream reaches; (4) obtain landowner permission to perform evaluations on these stream reaches; (5) initiate probabilistic monitoring operations; and (6) develop a methodology for applying probabilistic data in 305(b)-based water quality assessments. Probabilistic monitoring was implemented in June 2006 under the auspices of the newly created Kansas Stream Probabilistic Monitoring Program (SPMP). The program periodically updates its methods, as noted in the Quality Management Plan (KDHE 2019a).

From its inception, the SPMP was designed to complement (rather than supplant) the department's traditional monitoring programs. Targeted monitoring continues to serve as the primary basis for assigned Integrated Reporting categories and 303(d) list development, TMDL formulation, and NPDES permit review and certification. Although site selection procedures for the probabilistic and targeted monitoring programs differ substantially, field methodologies developed for the targeted efforts have been integrated with little alteration into the probabilistic program. This decision has maintained methodological continuity across programs and facilitated inter-program data comparisons. Chemistry and biological data generated by the SPMP and targeted monitoring programs are uploaded to the same electronic databases. Staff from the targeted and probabilistic monitoring programs work together to provide mutual assistance as well as to improve field and data management methods.

The stream probabilistic monitoring network is predicated on a random, but spatially balanced, site selection process (Urquhart *et al.*, 1998; Herlihy *et al.*, 1998, 2000). Site coordinates are based on the random selection of points from the universe of classified streams identified in the most recently approved version of the Kansas Surface Water Register (KSWR) (KDHE 2013a). The KSWR represents all potential probabilistic sampling locations or "the sampling frame." A single survey design yields a very large number of potential sample points on the KSWR. The resulting list is used to generate a manageable subset of about 30–50 new sites to be sampled each year (Figure 5). Results generated through the probabilistic monitoring program can be extrapolated with known statistical confidence to the state's entire population of streams, including hundreds of smaller water bodies largely outside the historical and current purview of the targeted monitoring programs.

As an integral part of monitoring and assessment, the stream probabilistic monitoring program also maintains and samples a network of reference sites that represent the best known available and accessible sites across a range of stream size classes, ecoregions, and river basins. Data from these sites provide the thresholds that are used to determine aquatic life use support for 305(b) assessment.

The program has generated a great deal of side-by-side chemistry and biological data. Its databases include over 180,000 water chemistry analytical records from over 2,800 sample events (2006-2018) as well as over 23,000 high resolution (predominantly genus/species level) macroinvertebrate taxonomic records from 600 separate sample events (2006-2016). The program collaborates with the Fish Tissue Contaminant Monitoring Program to take fish tissue samples at every site that contains harvestable fish species of edible size, which is typically about two thirds of sites in a given year. The SP fish tissue program has generated over 750 fish tissue mercury samples from across the state. In addition, the SPMP also does freshwater mussel surveys at every site.

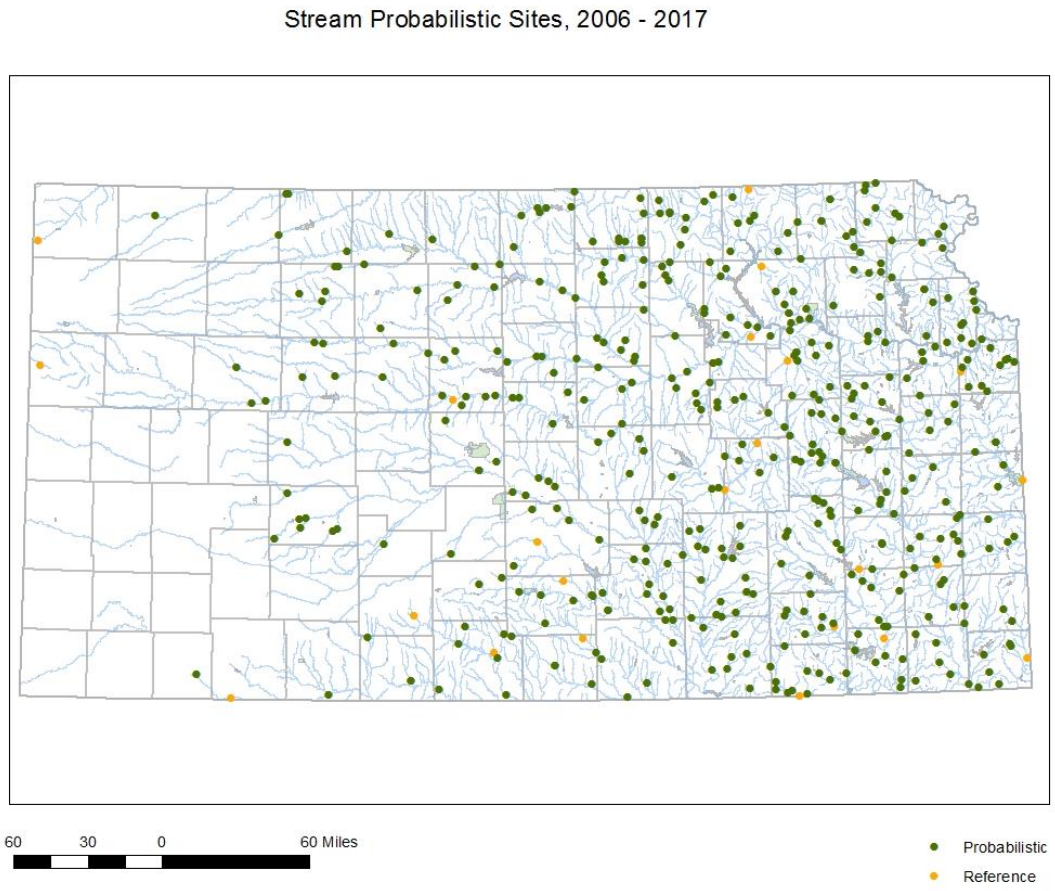

Figure 5. Stream Probabilistic Monitoring Sites.

Groundwater Quality Monitoring Program

Kansas no longer maintains a statewide groundwater quality monitoring program. However, an earlier monitoring program (suspended in 2002 owing to budgetary constraints) evaluated groundwater quality at more than 200 sites in Kansas. Individual wells in the monitoring network were sampled on a two-year rotational basis, with approximately half these wells being sampled in any given year. All wells in the network adhered to specific siting, depth, and construction criteria, and the network as a whole was deemed representative of the state's major aquifer systems. The program's surviving electronic database contains roughly 150,000 records spanning 120 different physical, chemical, and radiological parameters and 327 groundwater quality monitoring locations. Additional background information is presented in the program's QMP and accompanying set of SOPs, last revised in December 2000 (KDHE 2000b).

Some groundwater quality data continues to be gathered by KDHE through the efforts of its major regulatory bureaus. For example, groundwater is sampled routinely by the Bureau of Environmental Remediation from the vicinity of nearly 200 abandoned landfills and groundwater remedial sites, 1,500 storage tank cleanup sites, and a few active surface mining operations. The Bureau of Waste Management obtains groundwater quality information from a few dozen active landfills and hazardous waste sites across the state. The Bureau of Water requires a number of major NPDES permit holders to periodically submit data on groundwater quality; examples include larger confined animal feeding operations, certain industrial operations (*e.g.*, meat processing facilities, power plants, injection wells), and a few municipal wastewater treatment plants. All of these monitoring activities focus on surficial groundwater and/or a very limited set of analytical parameters. Although public water supply systems are monitored for a wide range of parameters pursuant to the federal Safe Drinking Water Act, samples are collected after treatment and do not reliably reflect the condition of the raw water source. These assorted monitoring operations are not intended to provide representative information on the state's major aquifer systems or to serve as a coordinated and comprehensive ambient groundwater quality monitoring program.

Compliance Monitoring Program

This program evaluates the quality of treated effluent released into the environment by wastewater treatment plants and other discharging facilities. It also provides an independent means of evaluating the accuracy and completeness of self-monitoring and reporting information provided by holders of NPDES permits. Parameters selected for analysis vary from one discharging facility to the next in accordance with effluent limitations and monitoring requirements specified in individual discharge permits. Supplemental parameters are also sometimes included in these compliance analyses for regulatory planning purposes.

The scope of this program is statewide, and all NPDES facilities in the state potentially are subject to unannounced compliance monitoring visitations (40 CFR 123.26(b); K.S.A. 65-170b; KDHE 2019b). In the past, the agency has visited about 60 NPDES facilities each year for compliance monitoring purposes. However, since 2009 there have been approximately 20 facilities monitored each year with details for the number of facilities monitored each year displayed in Figure 6. These

numbers reflect an overall decline in the staffing allocated to the compliance monitoring program.

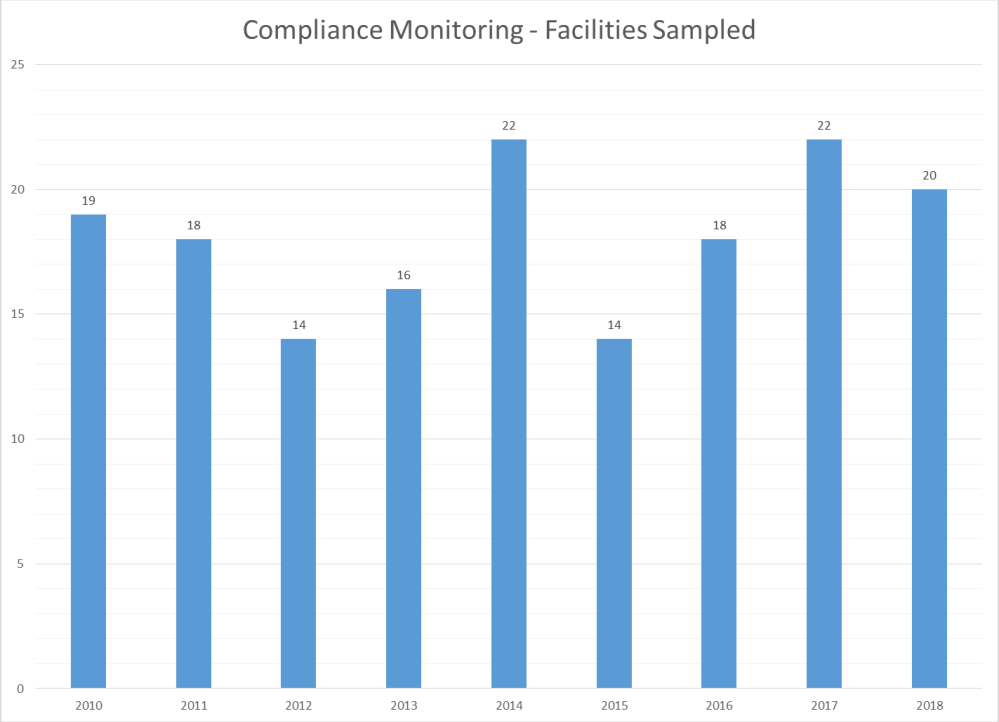

Figure 6. Number of facilities sampled each calendar year for compliance monitoring.

Use Attainability Analyses (UAAs)

The attainable uses of essentially all classified surface waters in Kansas were systematically reevaluated by BEFS during 2003–2007. In 2004 alone, more than 650 streams segments were surveyed to determine their classification status and capacity to support several newly defined recreational uses (*cf.*, K.S.A. 82a-2001 *et seq.*; K.S.A. 82a-2004). Programmatic efforts in 2006 and 2007 shifted to the assessment of other beneficial uses such as aquatic life support, food procurement, water supply, and groundwater recharge. By December 31, 2007, UAAs had been completed for nearly all water bodies identified in the Kansas Surface Water Register. Only a few additional UAAs were performed by BEFS during 2008–2010. These surveys were requested by BOW and supported NPDES permit development functions.

As needed, the scientists in the BOW Watershed Planning, Monitoring, and Assessment Section perform use attainability analyses (UAAs) to obtain geographical, geomorphological, hydrological, chemical, and/or biological data valuable for determining the attainable uses of individual water bodies (KDHE 2005a). The results of these surveys undergo formal in-house review, public comment, and, ultimately, EPA review and approval. Approved use designations are codified in the Kansas Surface Water Register (KDHE 2013a) and adopted by reference in the Kansas Surface Water Quality Standards (K.A.R. 28-16-28g). The level of water quality protection afforded by the standards varies among classified water bodies in accordance with these use

designations and associated water quality criteria (K.A.R. 28-16-28d and -28e). Currently, UAAs are typically performed upon request or on an ad hoc basis when readily available information identifies the need for a revision to an existing UAA. Revisions to existing UAAs are often completed utilizing geospatial tools along with any site information provided by monitoring program staff during recent visits.

Special Water Quality Investigations

The BOW staff in the Watershed Planning, Monitoring, and Assessment Section participate in a variety of special investigations and responses pertaining to water quality monitoring and data evaluation. Emergency situations that generally elicit investigative responses include contaminant spills, sewage bypasses, and taste and odor problems in drinking water supply reservoirs. Section staff also perform special water quality investigations in support of TMDL studies, special administrative initiatives, interstate water pollution studies, Natural Resource Damage Assessment (NRDA) projects, multi-state water quality surveys (*e.g.*, National Rivers and Streams Assessment), or other monitoring/assessment initiatives (*e.g.*, Kansas Reference Stream Study). In most years, section employees are engaged in at least one or two investigations of this kind.

Fish Kill Response

On average, KDHE receives about 40 fishkill reports each year. Most originate from landowners or other concerned citizens, and nearly all prompt field investigations by the BEFS district offices and/or the regional KDWPT offices. Because the BOW central office employs a number of experienced aquatic biologists, maintains several boats, and has access to specialized sampling and diagnostic equipment, they are sometimes requested by the district environmental administrators to participate in large or unusual fishkill investigations. The BOW Watershed Planning, Monitoring, and Assessment Section recently assumed primary responsibilities for managing fish kill response coordination, with the shifting of functions from BEFS central office staff in 2018.

Harmful Algal Bloom Response

Since 2010, the department has operated harmful algal bloom (HAB) monitoring at public recreational lakes based on responses to complaints. Upon receipt of a complaint for KDHE to investigate a blue-green algal bloom, confirmation is determined through visual indicators in the affected waterbody, with confirmation of a positive jar test indicating blue-green algae are present. KDHE BOW central office coordinates sampling of the waterbody with the BEFS district offices. Samples are analyzed for the concentration levels of toxins associates with HABs, along with optional blue-green cell counts when resources allow. BOW Watershed Planning, Monitoring, and Assessment Section staff follow protocols and procedures within the "Harmful Algal Bloom KDHE Agency Response Plan" to determine whether public health advisories should be issued and the next course of action for sampling activities in the affected waterbody (KDHE 2018b). Response functions occur during the recreational season, from April 1 – October 31, when lakes are most likely to be affected by HABs and when members of the public are most likely to recreate.

In 2010, KDHE issued advisories for a total of nine lakes. From 2011-2018, the average number of lakes with harmful algal bloom advisories (Watch, Warning, or Closure) has increased to 22. The department went from collecting 126 samples in 2010, to an average of 207 sampler per year during the time period from 2011-2018.

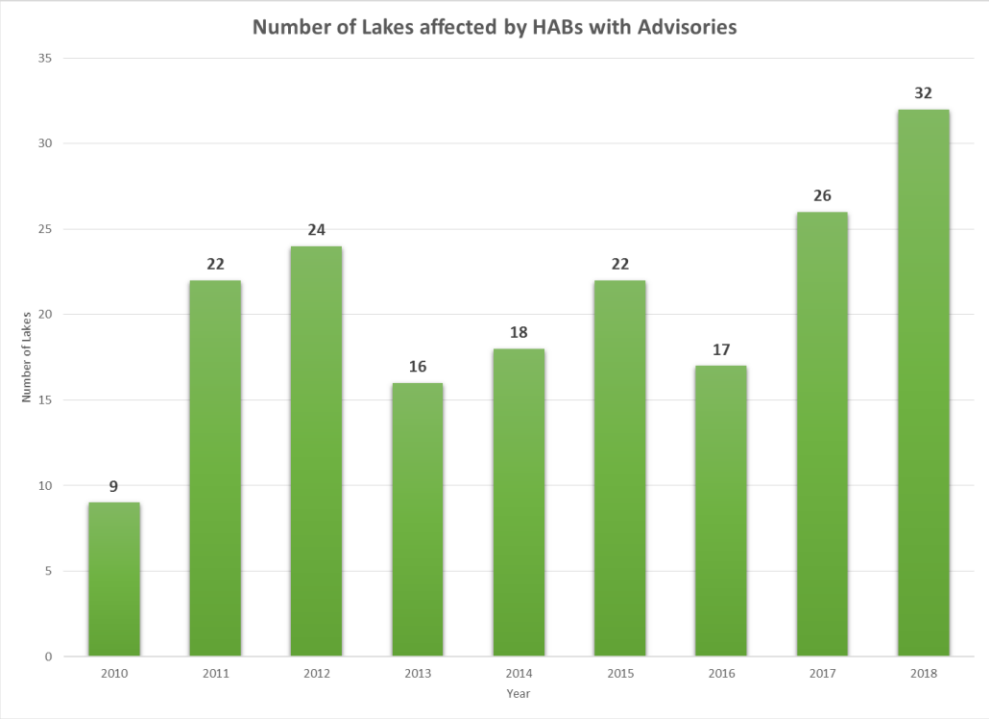

Figure 7. Number of lakes in Kansas that were issued a HAB advisory in calendar years 2010-2018.

Due to nutrient impairments along with other climatological factors, some lakes in Kansas have experienced prolonged periods with HABs and an associated advisory (*e.g.*, Milford and Marion Reservoirs). This has prompted the KDHE BOW to initiate efforts for in-lake mitigation techniques of HABs in problematic waterbodies, which will increase monitoring efforts within these affected lakes, to reduce the frequency and duration of bloom events.

Collaborative Monitoring Programs

Some outside organizations routinely lend monitoring assistance to KDHE or otherwise generate data suitable for inclusion in the agency's water quality assessment reports. For example, EPA Region 7 and the Kansas Department of Wildlife Parks and Tourism (KDWPT) routinely assist KDHE with the collection of fish tissue samples from some of the state's larger streams and reservoirs (KDHE 2013b). The United States Army Corps of Engineers obtains and shares information on bacteria concentrations in federal reservoirs maintaining public swimming beaches. Recipients of NPDES permits submit electronic discharge monitoring reports to KDHE

on a regular basis; these reports convey information regarding the amount of effluent discharged to the waters of the state, measured levels of selected contaminants, and, in some cases, the risk posed by the treated effluent to aquatic organisms (as determined by standardized laboratory toxicity tests). The United States Geological Survey (USGS), the Kansas Geological Survey, and the Kansas Biological Survey sometimes are commissioned by KDHE to perform special water quality, sediment quality, or biological studies, often in support of TMDL development or Harmful Algal Bloom initiatives. Under contractual agreements with the department and the Kansas Water Office, the USGS also monitors stream flow at 216 locations in the state (http://waterdata.usgs.gov/ks/nwis/current/?type=flow) and collects water quality information at 21 active sites (https://waterdata.usgs.gov/ks/nwis/current/?type=quality&group_key=NONE). This flow gauging network plays a critical role in the establishment of water quality-based permit limits and development of TMDLs for water quality-impaired streams. Additionally, KDHE assists EPA Region 7 with the Regional Monitoring Network program by participating in field activities either collaboratively or on their behalf.

Volunteer Monitoring Programs

Most volunteer water quality monitoring programs in Kansas support broad environmental education objectives. Owing primarily to quality control constraints, the information obtained through these programs generally is not applied by KDHE in a formal assessment or regulatory context. Future opportunities for volunteer monitoring may be associated with the Kansas WRAPS program, which provides a multi-agency framework for addressing a variety of water resource issues, such as the achievement of TMDLs, protection of public water supply reservoirs, and the restoration of wetland and riparian habitats. Additionally, there are other interest groups that periodically perform volunteer monitoring and communicate results of interest to KDHE. Data collections and observations along the Kansas River are regularly reported by Friends of the Kaw. With the increase of harmful algal bloom events in Kansas, there are more lake managers performing jar tests. These results are communicated with supporting photos to KDHE frequently and often trigger a response for formal monitoring.

Data Management

In 1999, EPA replaced its original STORET (data STOrage and RETrieval) system with a newer version (STORETX) that required data migration software to be installed on all uploading computers. A refined version of this software became available in 2001 for use in an ORACLE operating environment. In 2002, KDHE switched from the AS-400 mainframe to a Xiotech storage area network (SAN) and Hewlett Packard server-based system with ORACLE operating software. This change was needed to better harmonize with STORETX and other federal databases operating on an ORACLE database platform. In 2003, KDHE's Office of Information Systems (later renamed Office of Information Technology) successfully migrated a portion of the stream chemistry database (1986–2002) to ORACLE.

During 2005 and early 2006, four years of stream chemistry data and five years of lake chemistry data were uploaded to STORETX. However, in the spring of 2006, EPA announced that

STORETX would be replaced by a newer federal database known as the Water Quality Exchange (WQX). Kansas and most other states ceased transferring data to STORETX and waited instead for the EPA WQX to become fully operational, a process that required nearly three years. By the fall of 2009, KDHE had developed a state-oriented version of WQX for database transfer purposes and had begun uploading data from this system to the EPA WQX. By August 2010, essentially all surface water chemistry data obtained by KDHE during 1999–2009 had been transferred to EPA WQX. The STORET warehouse was decommissioned in June 2018.

WQX uploads and data transfers are routinely completed annually. Stream data uploads from 2014-2016 lagged due to issues with a few parameters from the laboratory data. All issues have been resolved and lake, stream, and biological data are all uploaded on WQX routinely by the Bureau of Water. Lake and stream data are uploaded to WQX the year following the data collection, after the data has been validated. Biology data uploads lag a year due to the time it takes to perform macroinvertebrate identification work, where data is uploaded two years following sample collection. All data uploads are to remain on schedule and up to date. If there are any isolated issues with specific data sets or parameters, these may be withheld from the larger uploads until such issues are resolved. Uploads will occur on schedule for the validated data as these isolated issues are being resolved, followed by a secondary upload to complete the data set upon resolution.

Under the same framework that requires states to upload raw data to WQX/STORET, states now are also required to upload their surface water assessment data and impaired waters listings to US EPA's ATTAINS (Assessment, TMDL, Tracking and Implementation System). The upcoming assessment cycles (2020-2022) will represent a period of adjustment to the new system.

Quality Assurance/Quality Control

The foremost goal of the Division of Environment (DOE) quality management system is to ensure that all environmental monitoring programs and projects administered by the division produce data of known and acceptable quality and support, in a scientifically defensible manner, in support of the informational needs and regulatory functions of KDHE. Part I of the DOE Quality Management Plan (QMP) establishes the general framework for this quality assurance management program (KDHE 2018c). Quality assurance goals, policies, procedures, organizational responsibilities, and evaluation and reporting requirements are specifically addressed in this document, and the foundation is laid for the bureau- and program-level quality assurance plans presented in Part II and Part III of the QMP. Written quality assurance plans have been developed for all routine environmental monitoring programs administered by the BOW Watershed Planning, Monitoring, and Assessment Section. Each plan describes:

(1) the objectives and goals of a particular program, along with historical background information;

(2) programmatic quality assurance goals and expectations;

(3) organizational (staff/supervisor/administrator) responsibilities;

(4) quality assurance procedures for monitoring site selection, sample collection, chain-of-custody, field and laboratory analyses, internal and external quality control assessments, corrective actions, data management, equipment/supply purchasing, and quality assurance reporting;

(5) standard operating procedures (step-by-step instructions for sample collection, preservation, transport and analysis, equipment maintenance/calibration, related safety procedures, and other routine programmatic activities); and

(6) additional information such as field and laboratory equipment checklists, standardized field sheets, sample submission and chain-of-custody forms, a glossary of applicable technical terms, and bibliographical citations for further reading and information.

Quality assurance documents for all departmental programs generating environmental data are posted on the DOE quality assurance website at: http://www.kdheks.gov/environment/qmp/qmp.htm

Evaluation of Monitoring Programs

Water quality monitoring programs administered by the department are subjected periodically to both internal and external quality assurance evaluations. These generally take the form of data quality assessments, performance audits, or management system reviews. Data quality assessments address whether the type, quantity and/or quality of environmental data collected by a given monitoring program support the informational needs of the administering bureau and the division. These assessments focus largely on sampling design and monitoring frequency and the general adequacy of the collected data relative to the stated purpose of the monitoring effort. The EPA document *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (EPA 2000b) serves as the principal written guidance for data quality assessments. Evaluations of this kind are performed by the BOW QA representative, unit chief or section chief of the Watershed Planning, Monitoring, and Assessment Section based on perceived need or according to schedules set forth in the bureau-level QA management plan or applicable programmatic QMPs. Corrective actions stemming from these assessments are addressed by the section chief and program managers in end-of-year program evaluation reports.

Individual monitoring programs are audited annually by the respective unit chief or section chief and may be audited from time to time by the divisional QA officer, bureau QA representative, federal oversight agency, or an independent third party contracted by the division or oversight agency. Most programmatic audits are performed by the section chief or bureau QA representative based on perceived need or according to schedules set forth in the bureau QA management plan or applicable QAPPs. These audits consider the adequacy of physical facilities, equipment, personnel, training, field and laboratory procedures, record keeping, data validation and management, and other aspects of the monitoring program. The EPA document *Guidance on Technical Audits and Related Assessments for Environmental Data Operations* (EPA 2000d) serves as the principal written guidance for planning and implementing internal audits. Corrective actions stemming from

audits are approved and implemented pursuant to procedures addressed in the divisional QMP and are summarized by the section chief and program managers in annual program evaluation reports.

Management system reviews are implemented at the divisional level to determine whether environmental monitoring operations and the supporting management infrastructure comply with the stated goals and requirements of the QMP. To date, all management system reviews have been performed by auditors from EPA under the direction of the EPA regional QA manager. Evaluations of this kind are implemented with the prior knowledge and consent of the DOE QA officer and division director. Management system reviews normally follow the guidelines set forth in the EPA document *Guidance on Assessing Quality Systems* (EPA 2003b). These reviews help identify needed corrective actions and other opportunities for improving QA performance. The results of these assessments are summarized by EPA in writing, then distributed to the division director, divisional QA officer, and participating bureau directors, bureau QA representatives, section chiefs, and program managers.

Infrastructure Planning

Departmental operations involving the generation and analysis of environmental monitoring data are systematically planned and documented pursuant to the requirements of the QMP (KDHE 2010a). Planning tools include, but are not limited to, the departmental budget, the performance partnership agreement with EPA, work plans associated with other federal grants and agreements, the continuing planning process (KDHE 1998a), and this document, the monitoring and assessment strategy. End-of-year program reports and DOE's annual QA report to EPA also serve in a planning capacity by addressing staff training needs, pending corrective actions, and upcoming QA initiatives and assessments. The SOPs contained in Part III of the QMP likewise constitute formal planning tools for both intramural and extramural environmental monitoring programs. In developing an SOP or Quality Assurance Program Plan (QAPP), the program manager (or outside contractor) is expected to obtain input from persons or organizations requesting the monitoring data or representing the ultimate users of the data. The program manager also is expected to solicit comments from field, analytical, data management, supervisory, and other personnel participating in the monitoring program. Prior to implementation, each SOP or QAPP must be reviewed and approved by the section chief for conformity with organizational practices, policies, and priorities and by the bureau QA representative for conformity with applicable QA requirements. The EPA document *Guidance for the Data Quality Objectives Process* (EPA 2000c) is used as a tool in the QAPP planning and development process.

Overview of Current Assessment Operations

Water Quality Assessment (305(b)) Report

Since 2008, the biennial 305(b) report has been incorporated within a larger document known as the Kansas Integrated Water Quality Assessment (IWQA). The 305(b)-related portion of the IWQA assesses the state's overall water quality condition using information obtained from the aforementioned monitoring programs. Reporting efforts have focused primarily on the condition

of classified streams, lakes, and wetlands in Kansas (KDHE 2018a). Earlier 305(b) reports, predating the suspension of the groundwater quality monitoring program, also evaluated the condition of the state's major aquifer systems (*e.g.*, KDHE 1996a, 1998b, 2000c). In general, only the data obtained from a program's most recently completed monitoring (rotational) cycle are considered during document development (*e.g.*, four consecutive years of stream probabilistic monitoring data).

The 305(b) portion of the report relies on a multifaceted screening level evaluation that is intended to be a reliable estimate of overall stream health, but is not meant to be definitive for impairment listings. Assessment criteria vary from one monitoring location to another depending on the designated uses of individual stream reaches, lakes, and wetlands. Measured water quality conditions are compared with applicable narrative or numeric criteria presented in the Kansas Surface Water Quality Standards or in guidance documents published by EPA (*e.g.*, EPA 2000a). In the translation of narrative biological criteria, the agency applies a suite of biological assessment indices that include, for example, the macroinvertebrate biotic index (MBI), Kansas biotic index (KBI), Ephemeroptera-Plecoptera-Trichoptera (EPT) index, and overall richness. Monitored water bodies are evaluated and classified as either supporting or not supporting of each designated use. The overall level of use support then is calculated for the entire population of monitored streams, lakes, and wetlands and presented along with other relevant information in the 305(b)-related portion of the IWQA (http://www.kdheks.gov/tmdl/index.htm).

The department's most recent 305(b) assessment evaluated the condition of 19,284 of the state's 30,278 classified stream miles (64% of the state's total classified stream length). Drought conditions and dry creek channels precluded the evaluation of the remainder. The 305(b) assessment reported on the conditions of 183,397 lake acres using both chemical and biological data, as well as an additional 5,673 acres using biological data alone; the sum (189,090) accounts for essentially all (190,445 acres) of the classified lake area. The IWQA also included results on 55,969 acres of classified wetlands. Classified waters that were not well represented in the 305(b) assessment included a few hundred publicly owned or publicly accessible lakes and wetlands, most smaller than 10 acres (4.0 ha). Moreover, the Missouri River is not typically considered in the 305(b) assessment owing to logistical and budgetary constraints that preclude the collection of representative physicochemical and biological data from this large interstate waterbody (KDHE 2018a).

Water Quality-Limited Surface Waters and TMDLs

Pursuant to section 303(d) of the Clean Water Act, each state must maintain an inventory of all streams, lakes, and wetlands within its borders failing to meet one or more designated uses associated with applicable surface water quality standards. States also must consider "all existing and readily available water quality-related data and information" during the development and periodic revision of this inventory (40 CFR 130.7(b)(5)). In the identification of water quality-impaired surface waters and the assignment of the respective Integrated Reporting categories in Kansas, KDHE relies primarily on information obtained through the previously mentioned (targeted) water quality monitoring programs. Secondary sources of information include special water quality investigations, nonpoint source pollution surveys, drinking water source

assessments, contaminant dilution calculations, trend analyses, predictive modeling, fish/shellfish consumption advisories, and information provided by other governmental agencies, academic institutions, and the general public.

Proposed modifications to the 303(d) list undergo internal, interagency, and public review and ultimately must be approved by EPA. The list is developed in accordance with the *Methodology for the Evaluation and Development of the Section 303(d) List of Impaired Water Bodies for Kansas*, which is revised each listing cycle (KDHE 2018d). Because water bodies identified on the 303(d) list are assigned a priority ranking for TMDL development (discussed below), this document significantly influences KDHE's day-to-day regulatory operations and its long-term targeting of watersheds and water bodies for environmental restoration. The department's most recent 303(d) list (2018) was approved by EPA on April 13, 2018 and identifies 383 stream station/pollutant -related water quality impairments and 115 lake/wetland station/pollutant water quality impairments distributed among 67 HUC8 watersheds. The 2018 list also identifies 480 station/pollutant combination of waters that were previously cited as impaired in prior lists but now meet water quality standards, with 19 of these being new in 2018 (KDHE 2018e). This list undergoes extensive internal and public review prior to EPA approval and is available at http://www.kdheks.gov/tmdl/methodology.htm.

Total maximum daily loads constitute established limits on the release of pollutants to the waters of the state. Waters listed on the 303(d) list are targeted for TMDL development according to a priority ranking proposed by KDHE and approved by EPA. In developing a TMDL, the department specifies (1) the waterbody in question, (2) the pollutant causing the water quality impairment, (3) the degree of deviation from applicable water quality standards, (4) the level of pollution reduction needed for regulatory compliance, (5) corrective actions needed to achieve this reduction, (6) monitoring strategies needed to assess the impact of the corrective actions, and (7) provisions for modifying the TMDLs, if needed, based on future monitoring and assessment information.

Since 1999, TMDL development efforts in each of the state's twelve major river basins have attempted to adhere to a five-year rotational schedule. With the emergence of a Kansas TMDL Vision, consistent with the approach supported by EPA's national TMDL Program, significant alteration in scheduling has been made for the years 2014- 2022 (KDHE 2016). Kansas TMDL Vision is tied to KDHE's Nutrient Reduction Framework and focuses on stream phosphorus or nitrate impairments within 16 HUC8's deemed as high priority. As time permits, secondary impairments caused by excessive nutrients including pH, deficient dissolved oxygen or lake eutrophication, may also have TMDLs developed within the priority 16 HUC8 sub-basins. This priority schedule means that no TMDL development will be conducted in other basins of the state. Additionally, current plans to address impairments other than nutrients will be deferred until after 2022.

Since 1999, the Kansas TMDL program has addressed impairments in each of the state's twelve major river basins. As of 2018, the 303(d) list includes approved TMDLs addressing 303(d) listed impairments for 3,155 stream segment/pollutant combinations and 310 lake/pollutant combinations.

For more information on Kansas' TMDL Visioning Process or the Kansas TMDL Development

Cycle, visit the program website at: http://www.kdheks.gov/tmdl/planning_mgmt.htm.

Water Quality-Based Effluent Limits

Prior to the issuance of any permit that authorizes a facility to discharge effluent to the waters of the state, KDHE must certify in writing, that the planned release of effluent will not result in violations of the Kansas Surface Water Quality Standards, other applicable state laws, or any federally promulgated water quality standards (CWA §401(a)(1); 40 CFR 124.53). A review of the discharge's potential impact on the quality of the receiving surface water is conducted by the BOW Watershed Planning, Monitoring, and Assessment Section. This review generally involves the use of desktop computer models and the application of certain standard assumptions related to mixing zone dimensions, pollutant decay rates, stream re-aeration coefficients, and other instream features and processes. Limits on allowable concentrations (or loadings) of certain pollutants may be established by the department based on the receiving surface water's designated use(s), estimated assimilative capacity, measured background (upstream) pollutant concentrations, and the projected mean and maximum rates of effluent discharge. Any approved TMDLs or 303(d) impairment listings for the receiving surface water (or other, downstream waters) are considered during this review. The department may require permit holders to monitor actual discharge rates and levels of selected contaminants in the treated effluent. Additional requirements may be imposed depending on the degree of uncertainty inherent in the certification analysis and other factors (KDHE 2014b).

Approximately 1,040 municipal, industrial, commercial, and federal facilities in Kansas are authorized by KDHE to release treated effluent to the waters of the state. Discharge permits normally are reviewed and renewed on a five-year cycle; hence, about 200 permits are issued each year, on average. The Bureau of Water currently reviews these permits on a basin-by-basin rotational basis, which was previously consistent with the aforementioned TMDL schedule. This coordinated approach was originally intended to allow wasteload allocations generated through the TMDL process to be incorporated more rapidly and more comprehensively into permits issued by the department (KDHE 2014b). Since 2008, wasteload allocations are readily available for staff interpretation and reference through the comprehensive TMDL and 303(d) database managed by the section.

Nonpoint Source Pollution Report

Pursuant to subsection 319(h)(11) of the Clean Water Act, the BEFS Watershed Management Section prepares an annual report of progress each year describing the state's NPS pollution control objectives, drinking water protection strategies, watershed restoration/protection strategies, projects implemented during the previous year in support of these objectives, plans, and strategies, and any noted improvements in water quality attributable to NPS pollution control efforts. This annual report also presents on the status of milestone indicators used to determine the efficiency of the strategies outlined in the Kansas Nonpoint Source Management plan as well as TMDL development efforts within each basin. Additional technical materials and professional contact information are included in this report for the benefit of other agencies, organizations, and

individuals engaged in the study and control of NPS pollution.

Special Water Quality Reports and Presentations

In addition to the major assessment reports considered already, the agency generates a large variety of in-house reports, special publications, invited articles and commentaries, and peer-reviewed journal articles addressing the integrity of the state's surface water and groundwater resources. Departmental water quality data also are sometimes included in the reports and publications of other agencies, organizations, and academic institutions. Most scientists and engineers employed by BOW belong to at least one professional organization and regularly attend regional and national conferences and workshops for the purpose of sharing and acquiring information relevant to their work at KDHE.

There has been tremendous demand to provide detailed technical summaries on various water quality issues throughout the state. These assessments are extremely important to the department and other agencies to assist with a variety of environmental decisions. Often these assessments are summarized with brief write ups and presentations. Staff presentations are frequently requested by schools or universities, professional associations, conference planning committees, and technical workgroups. Likewise, staff are needed to interpret technical summaries for public meetings, technical workgroups, legislative testimony and media interviews. Collectively, these informational outlets play an important role in maintaining and improving the public's knowledge of the water quality issues facing Kansas (KDHE 2004a). Moving forward, special reports are generally limited to address high priority bureau, section, and program level water quality issues to efficiently maximize resources and staff time, with the broader focus on concise technical information exchange and outreach activities.

Planning and Evaluation of Assessment Programs

The monitoring and assessment strategy, this document, constitutes one of the department's primary planning tools for water quality assessment operations. Other major planning tools include the departmental budget, the performance partnership agreement with EPA, work plans associated with other federal grants and agreements (*e.g.*, Clean Water Act §604(b) grant), the divisional QMP (KDHE 2018c), the Harmful Algal Bloom Response Plan, the TMDL vision, the Integrated Water Quality Assessment Report, and the continuing planning process (KDHE 1998a). Water quality assessment programs within KDHE are evaluated largely on the basis of written work products (*e.g.*, IWQA; TMDLs; annual NPS report; reports stemming from special water quality monitoring initiatives). All such products undergo some level of in-house review, and many are submitted to other governmental agencies and/or the general public for additional review and comment. Modifications to the Kansas Surface Water Quality Standards, surface water register, revised 303(d) lists, and proposed TMDLs are subjected to a particularly high level of public scrutiny and ultimately require the review and approval of EPA. Public comments and criticisms are considered carefully by program managers and other supervisory personnel and often lead to further improvements in the department's water quality monitoring and assessment programs.

Proposed Improvements in Kansas Water Quality Monitoring and Assessment Programs

The following paragraphs discuss preferred options for implementing improvements to the department's water quality monitoring and assessment programs during the upcoming ten year planning period. Appropriate funding levels should accommodate the implementation of any of these recommendations where applicable. These recommendations will be revisited in 2024 to assess progress and revise as necessary.

Recommendation #1: Harmful Algal Bloom cyanobacteria cell count alternatives

In Kansas, harmful algal blooms (HABs) have increased in both frequency and intensity since 2011. EPA recently released a final health recreational ambient water quality criteria and/or swimming advisory for microcystins and cylindrospermopsin, therefore it is recommended to revisit the current advisory thresholds utilized in Kansas. Of particular interest, is the potential to shift away from doing precise manual cyanobacteria cell counts. The level of time and expertise required to provide timely taxonomic identifications with accompanying cell counts is expensive and perhaps unnecessary with the accompanying toxin analyses. A recent change to the HAB response plan relies more heavily on toxin testing and provides flexibility around cell count analysis. This change was necessary due to the resource constraints associated with performing this function, since this function is contracted out in order to not interfere with other program functions during the recreational HAB season. More importantly, there is some evidence that advisories based on cell counts may be overprotective since a large proportion of lake advisories are not associated with the presence of toxins. Preliminary assessments in Kansas indicate cell counts do not necessarily correlate with the associated toxin concentration for several waterbodies, though this is not always the case. Nor does it appear that high cell counts predict subsequent high toxins are imminent. It is recommended to maintain the capability to identify cyanobacteria species and to utilize a modified procedure that provides a rapid cell count estimate. Thus, the department should endeavor to invest in new algal microscopy imagery technology (*e.g.*, FlowCam) that could provide seasonal microscopic algal taxonomic assistance (*i.e.*, perform automated estimates of cell counts) to readily process the algal samples collected during harmful bloom investigations for the timely issuance and updating of public health advisories. Additionally, the rapid algal assessment technology could also aid the monitoring programs that currently collect limited chlorophyll-*a* photosynthetic pigment data (as an indicator of eutrophic condition status) to increase the tracking of algal growth in more streams for the establishment of appropriate TMDL water quality endpoints. Since there are additionally a variety of automated processes that may be considered, it is recommended to collaborate with EPA Region 7 on replacement methods utilizing the FlowCam or other applicable technologies.

Recommendation #2: Subwatershed (WRAPS) monitoring expansion and amendment

The existing memorandum of understanding (MOU) developed in 2011 outlined the efforts of the Bureau of Environmental Field Services (BEFS) and the Bureau of Water (BOW) to perform the intensive monitoring of the targeted subwatersheds to determine baseline conditions and document

initial improvement in water quality stemming from the implementation of WRAPS plans. The original MOU is obsolete due to the reassignment of the water quality monitoring program operations (BEFS to BOW) in 2014 and the reorganization of the Watershed Management Section (BOW to BEFS) in 2018. Therefore, the MOU requires an update to reflect current management priorities. The Subwatershed monitoring program currently targets selected HUC12 locations within active WRAPS project areas. The selected subwatersheds have been targeted by KDHE for TMDL reduction and identified by WRAPS groups as high priority for implementation of WRAPS plans. These sites are monitored for a five-year period to establish a baseline for water quality to measure improvements in the project areas. The associated monitoring has included flow gauging activities to establish pollutant loads, which has proven difficult and resource intensive for the low quality data that has been captured. It is recommended to renegotiate and redefine the objective and priorities of the Subwatershed program to meet the current needs of the TMDL program and Watershed Management Section, while maximizing the existing efforts of other water quality monitoring programs collecting data in or near WRAPS project and TMDL watersheds. During the planning stage of a new strategy or MOU, the bureau representatives will need to re-address the purpose, roles and responsibilities each bureau will provide to ensure project success, and describe the resources each bureau will contribute to the program. For example, the planning process will need to consider the merits of the current monitoring activities (2011- 2019) and the possibility of allocating additional staff resources, or the utilization of summer interns or WRAPs Project Watershed coordinators to offset the workload of existing BOW monitoring staff that already have competing field work tasks and priorities. There are opportunities to improve the utility of other water quality monitoring programs to capture useful data for the Subwatershed program while meeting the needs and goals of the program capturing the data. Amending the Subwatershed program will require thoughtful planning, possibly modifying the future operations of other monitoring programs to provide added utility for Kansas. It is recommended to cease flow gauging measurements associated with Subwatershed monitoring. The collection of discharge data is time consuming and often needs to be conducted when resources are elsewhere since measurements often require rapid response actions to capture runoff events. It is further recommended that the discharge data to date be viewed as an estimate, due to the relatively low precision attainable by current methods. It is recommended to explore alternative methods for estimation of discharge, including but not limited to tapedown measurements, photographs from the day of sampling, along with techniques employed by the TMDL program to develop flow duration curves, to estimate flow and loading conditions. Other techniques to estimate flow should additionally be considered, such as evaluating the use of remote cameras.

Recommendation #3: Enhance the Stream Probabilistic Monitoring Program to align and improve state monitoring priorities

The Stream Probabilistic Monitoring Program is a resource demanding program due to the variety of media sampled (*i.e*. chemistry, biology, fish) and the associated workload of securing site access and sample processing. The stream probabilistic monitoring program was established in 2005 to address a gap in monitoring and assessment and is largely based on national initiatives and protocols. The program's most notable contribution have been in providing a valuable, unbiased and statistically defensible assessment of all of the state's flowing waters, which serves the Clean Water Act section 305(b) reporting requirements, as published biannually in the Kansas Integrated

Water Quality Assessment Report. In addition, it has generated a great deal of new knowledge about headwater stream conditions across the state. The most concrete contribution is that the fish tissue mercury data has resulted in a statewide fish consumption advisory. The program's data have contributed to the enhancement of the Kansas Surface Water Register, the state's map of flowing waters, as well as to advancement of field methods and assessment methods. It is recommended to evaluate and implement enhancements to maximize resources associated with water quality monitoring and the collected data, to further increase the utility of the data and tools generated by the program. It is recommended to generate a report on findings and accomplishments of the first ten years of the program, as well as the sustainability of every aspect of the program, from survey design and site selection to field methods, lab methods, and assessment methods. Consideration should be given to the modification of sampling site designs to add flexibility to ensure sites can be easily accessed (by staff and vehicles) and possibly serve as multi-purpose locations for other monitoring priorities (i.e. Subwatershed, WRAPS and TMDL effectiveness). Furthermore, it is important to ensure program sustainability with current fiscal and staffing commitments. It is recommended that enhancements to the objectives of the Stream Probabilistic Program comprise: a) support and supplement 305b reporting b) continue to enhance understanding of stream chemistry and biology information on small and headwater streams; c) continue to explore emerging monitoring methods and technology, functioning as a proving ground for methods that may be adopted by the program and potentially other monitoring programs, and d) coordinate more closely with other monitoring and assessment programs, in order to leverage probabilistic monitoring sites, where possible, to generate additional data that can serve multiple use.

Recommendation #4: Refine the Aquatic Life Use Support Index and conduct a mussel survey to capture water quality improvements

The Aquatic Life Use Support (ALUS) index is designed to assess the response of macroinvertebrate communities to a wide variety of stressors including nutrients, various toxics, low dissolved oxygen, and sedimentation. Following EPA Rapid Bioassessment Protocol guidance, data from candidate reference sites and regular targeted network sites were used to standardize the metrics to a dimensionless scale. The index is composed of five metrics and the metric scores are aggregated to generate the ALUS index score.

The ALUS index score has proven very useful with the evaluation of nutrient impairments and the development of TMDLs, particularly on larger streams. The index is used to identify the biology impairment, which is often associated with additional impairments such as total phosphorus and/or total suspended solids. Once listed as impaired, it has proven challenging to measure improvements and/or delist impaired waters with the current assessment and scoring system. There are multiple factors besides water quality that influence aquatic life use support, such as habitat and hydrology. These factors significantly influence the quality of biological communities but we have no authority to influence hydrology or habitat. The evaluation of biological improvement just from pollutant reduction is difficult, and the impact of these other factors should be considered in the process in order to ensure accurate representation of the water quality status of streams in Kansas. Currently, there are no methods employed to systematically incorporate the impacts of habitat and hydrology into 303(d) aquatic life use assessments, though habitat data has

been collected. It is recommended to improve or supplement the ALUS index to capture this information to better assess water quality improvements that may progress to the delisting of water quality impairments, in addition to amending the scoring system to reflect appropriate recovery and support of aquatic life. The focus should be based on measuring water quality improvements rather than delisting. Hence, the department plans to develop a more sensitive biological assessment model incorporating nutrient measures into assessment strategies. An effort will be made to develop a modeling technique using a numeric biotic nutrient-related index that incorporates measurements of total phosphorus and total nitrogen, aquatic life habitat characteristics, and hydrology effects assembled into indices for comparison between sites and years. This assessment approach will be analogous to a nutrient biotic index modeling technique developed by regulators affiliated with the New York State Department of Environmental Conservation to quantify human-induced impacts on aquatic biological condition (Smith et al., 2007).

It is further recommended to consider ancillary data, such as dissolved oxygen, pH, and chlorophyll along with Unionid (native freshwater) mussel surveys. Mussel surveys can provide informative information for assessing water quality improvements. It is recommended that the department conduct a systematic mussel survey to assess how the biological community has changed over time. Through 2013, the targeted biological monitoring program routinely conducted mussel surveys at every site. For long term monitoring sites a metric called "percent mussel taxon loss" was calculated, which was used in both 305(b) and 303(d) assessments. The stream probabilistic monitoring program performs a mussel survey at every site and has done so since 2006. Since reference sites are the only sites revisited, the data from probabilistic sites represent a snapshot of biotic health and are not used in tracking trends.

Recommendation #5: Improve transparency of surface water quality data through the agency website and water quality atlas

Significant improvements have been made to uploading KDHE water quality data to the EPA WQX database. The WQX system is a federal data warehouse that sufficiently stores KDHE's surface water quality monitoring program's data. Most individuals and organizations with large data requests are referred to the WQX system, since it is readily accessible via the internet. However, for others looking for refined data sets pertaining to a particular area or monitoring station, it is more efficient to obtain data directly from the agency. It is difficult to efficiently display the large amount of data KDHE warehouses associated with the surface water quality monitoring programs on the department's website. The water quality atlas is a good tool to geographically display monitoring sites along with a synopsis of the associated water quality data. The challenge with the data summary, is that it is has been a static display of outdated data. It is recommended to build upon the interactive mapping platform and incorporate an automated system to query and display readily available and quality assured current data to assist staff, agency partners, and the public.

Recommendation #6: Update the Kansas Surface Water Register

Defensible monitoring of any natural resource starts with an accurate and complete understanding of the resource being monitored. Kansas was well ahead of most states with the publication of the first Kansas Surface Water Register (KSWR) in 1994. The Register is a geospatially explicit list of the waterbodies of the state, along with attainable use designations for each (KDHE, 2013a). Along with the Surface Water Criteria, the KSWR provides the foundation for assessment as well as monitoring. Over the period from 2003 to 2007, the Department invested considerable resources toward refining the KSWR and its uses. The two primary results of this effort were a) removal of a significant extent of stream mileage where viable aquatic habitat no longer existed, and b) collection of site specific data that allowed accurate assignments of designated uses to individual waterbodies, especially aquatic life, food procurement, and recreational use.

The Stream Probabilistic Monitoring program performed a study on the completeness of the register in 2009-2010, and significant changes have been made to the National Hydrography Dataset, which is the geospatial dataset upon which the KSWR register is built. In addition, EPA has recently issued new guidance on the Waters of the US. Hence, it is recommended to perform necessary updates to the KSWR, which will also consider necessary actions associated the EPA decision document on the current KSWR.

Recommendation #7: Compliance monitoring enhancements

With the reduction in compliance monitoring operations throughout the years BOW has one staff member that is partially dedicated to the program. This staff member splits time assisting with stream monitoring activities associated with other programs. Though there are only about 20 sites sampled each year for compliance monitoring, more sites can be sampled by the dedicated program staff member. It is recommended for improved coordination between the newly structured BOW Water Permitting and Compliance Section and the Compliance Monitoring program to maximize resources and optimize site selections to meet the needs of the bureau. It is recommended to staff the other monitoring programs accordingly so the dedicated compliance monitoring staff member may add capacity to the number of sites sampled each year in accordance with the needs of the Water Permitting and Compliance Section. It is recommended to redirect compliance monitoring beyond the traditional sampling of major dischargers to: a) serve as a check on other NPDES initiatives; b) sample facilities with variances for ammonia; c) sample facilities where priority pollutant scans are required; d) sample small systems to assess nutrient outputs and e) retain flexibility to respond to the changing demands of unanticipated events, new pollutant criteria and guidance documents.

Recommendation #8: Develop or incorporate TMDL effectiveness monitoring, assessment and planning

As exemplified in the department's monitoring goals and objectives, the unabated documentation of spatial and temporal trends in the states' surface water quality routinely performed by the department's targeted monitoring programs has provided the primary water quality information

for the agency's 303(d) listing of impaired waters and development of Total Maximum Daily Loads (TMDLs). Amid the important work the targeted monitoring programs provide, the department recognizes the necessity to perform TMDL effectiveness monitoring and assessment to track changes in water quality as result of TMDL implementation. As the development of nutrient TMDLs has increased, it is evident additional monitoring events and/or locations are needed to assess the response to TMDL implementation, particularly by the biological community while capturing supplemental data associated with the TMDL endpoints. TMDL effectiveness monitoring should be considered after an established TMDL has substantial implementation among point and nonpoint sources in the watershed. It is recommended to incorporate adaptive management until TMDL endpoints are achieved for all aspects of this recommendation, where implementation is followed by monitoring and assessment, then plans are adjusted and followed by more implementation, monitoring and assessment until such endpoints are achieved. A monitoring strategy should be developed utilizing one or more of the existing monitoring programs or through the allocation of additional staff. Recognizing there is a tenuous relationship between nutrient levels and biological assemblages, the initial focus should be on the biological monitoring and capturing targeted biological data in TMDL watersheds addressing nutrients. Additionally, the assessment of nutrient improvement with chlorophyll and other TMDL endpoint parameters should be measured and assessed.

TMDL effectiveness monitoring at some point will require additional resources. The use of the EPA Region 7 laboratory should be considered through a cooperative agreement to provide analytical support to offset the departments' current deficiencies in analytical capacity. New innovative technologies such as multiparameter sondes or wireless data loggers could be deployed for continuous monitoring. Additional staff could provide the resource capacity to assess additional and alternate sampling locations tailored specifically for TMDL attainment status, perform more complex special water operations (*e.g.*, geometric mean-based bacteria sampling activities), and also provide additional fieldwork support for the existing targeted, compliance, subwatershed and probabilistic monitoring operations. Additional opportunities, to include funding, may be considered with the enhancement of the subwatershed monitoring program.

TMDL data assessments are necessary to prioritize monitoring decisions. A larger data assessment to evaluate water quality improvements after 50 years of the Clean Water Act, looking at data from 1972-2021, has been identified as a bureau goal. It is recommended to consider incorporating the long-term evaluation of water quality improvements throughout the state into the water quality assessments directed at priority TMDL watersheds, possibly accomplishing two goals simultaneously. Additionally, an assessment methodology may be developed that could be used for future data assessments to evaluate water quality improvements. It is recommended to initiate the larger data assessment to evaluate water quality improvements over the past 50 years during 2021 and 2022. The TMDL development schedule may allow for some staff resources to shift from TMDL development to assessment priorities during these years, which are identified as catch up years for TMDL development in accordance with the first iteration of the TMDL vision. The assessment will additionally assist with the formulation of the subsequent TMDL prioritization framework and development schedule for the years 2023-2028.

Recommendation #9: Improve water quality data management storage

Over the last decade, KDHE's water quality monitoring programs have developed critical database applications (built over an extended period) running Oracle Forms to significantly modernize the department's surface water quality database applications and system. There are indications that KDHE will soon be phasing out support functions for Oracle, which may require the department to transition to a new software. Moreover, the department's inability to retain an Oracle Forms programmer that has the expertise to write code for any new database application tailored to meet the department's current needs has been lacking within the last few years. Therefore, it is recommended the department identify a comparable software (with in-house programming expertise) to transition to a new application framework that can integrate the existing Oracle Forms stored procedures (*i.e.*, to perform the complex QA/QC data computations) while interfacing natively with the department's existing data management platform. This software transformation (*e.g.*, Oracle Forms to Microsoft.NET) will likely be a multifaceted process requiring the services of an outside consultant to provide migration tools to help with the planning and conversion. Likewise, the water quality monitoring programs have recently begun to transition away from an antiquated barcode data collection application, accessed on a PALM operated pen-notepad handheld, to a new mobile computer device (with similar barcode capture software) with an Android operating system.

Recommendation #10: Resume stream bacteriological monitoring initiative

In response to State legislation (K.S.A. 82a-2001 et seq. and 82a-2004) in 2003, the department promulgated revised water quality criteria for primary and secondary contact recreation in classified streams (K.A.R. 28-16-28e(c)(7) and 28-16-28e(d)). These criteria are expressed as maximum allowable geometric mean concentrations for *Escherichia coli*, an enteric bacterium commonly employed as an indicator of fecal contamination. The law specifies *E. coli* as the indicator bacteria and further specifies the frequency of sampling as five samples over a duration of 30 days (KDHE 2011). Kansas regulations contain single sample maxima (SSM) criteria for lakes, but there is not a single sample maxima criteria for streams. Calculation of the geometric mean at a given monitoring site requires the collection of surface water samples on five or more days during the course of a 30-day assessment period. Implementation at all monitoring sites in the state at this sampling frequency would correspond to an overwhelming increase in the department's environmental monitoring and analytical workload.

KDHE conducted monitoring at 20-25 sites per year from 2004-2014 in accordance with the bacteria criteria at sites distributed among selected river basins in anticipation of future 303(d) listings and a corresponding need to develop and implement TMDLs within these basins. Geometric mean sampling was ceased at the end of 2014 as the majority of the bacteria impairments throughout the monitoring network were identified, and the program proved to be resource intensive on staff and the laboratory. Additionally the focus on TMDL development shifted to nutrients.

It is recommended to reinstate capacity to conduct intensive bacteria surveys in accordance with the standards now that time has been provided for bacteria TMDL implementation to progress.

This initiative should be considered and evaluated with the enhancements to the Subwatershed (WRAPs) and TMDL monitoring initiatives.

Recommendation #11: Provide additional monitoring and assessment training

During the upcoming planning period, monitoring personnel will be encouraged to participate in national and regional water quality monitoring conferences and in any formal training that addresses recent advances in monitoring network design, sample collection methods, analytical and taxonomic techniques, quality controls, or other related subjects. The department will train additional employees in specific sampling, analytical and taxonomic skills to foster redundant capabilities in the event of retirement, injury, illness, or other factors leading to the loss or temporary absence of monitoring staff. Employees engaged in data analysis also will be encouraged to participate in specialized training (*e.g.*, statistical analysis and modeling workshops) offered sporadically by EPA and cooperating academic institutions.

Recommendation #12: Assess feasibility for additional parameters in monitoring programs

As time allows during the planning period, the department will evaluate the merit and feasibility of expanding its list of core and supplemental water chemistry parameters to include various additional volatile organic compounds (*e.g.* trihalomethanes, perchlorate), biocides (*e.g.* glyphosate), antibiotics (*e.g.* triclosan), dissolved organic carbon (DOC), per- and polyfluoroalkyl substances (PFAS), and synthetic hormones (*e.g.* estradiols). The prevalence and distribution of these compounds in the ambient environment remain poorly understood in Kansas. The primary challenge associated with adding new monitoring parameters is that the KDHE Health and Environmental Laboratories (KHEL) lacks the equipment and staff needed to complete the analysis for many of these compounds. It is recommended to continue dialogue between BOW and the laboratory to identify possible options to add additional parameters that are of importance. It is recommended for BOW to prioritize the parameters they would like added for analysis and evaluate possible adjustments to the current parameter list that may allow for inclusion of new priority parameters. It is also recommended that BOW collaborate with EPA Region 7 and our surrounding states on their efforts on sampling and analyzing these parameters, particularly PFAS. At this time, monitoring of glyphosate and PFAS would be the key parameters BOW would like monitored. It is recognized that this recommendation will likely remain challenging to address within this planning period.

Recommendation #13: Improve capacity for data interpretation and analysis

Water quality monitoring program staff are familiar with monitoring locations, site conditions, and the resulting water quality data. Data projects are often difficult to undertake to some degree by staff due to their responsibilities in the field or in the BOW laboratory performing various analysis. The majority of these projects are associated with priority requests from within the department to interpret a variety of water quality issues. Water quality monitoring staff within the section are highly knowledgeable about the data they collect and have the skills to work with scientific data,

and in many instances are the ones best suited to perform technical data analysis for priority projects related to their program areas. It is recommended to ensure programs function to accommodate additional end-user data projects and or outreach activities to share specific information related to their programs data and area of expertise. Hence, staffing capacity should be maintained or expanded to ensure program staff have sufficient time within their schedules to balance data analysis projects with the field activities associated with data collection. A thorough data evaluation associated with nutrients in Kansas streams and lakes is recommended, starting with the identification of the best lakes in Kansas to evaluate the relationship between chlorophyll *a* and corresponding nutrient concentrations. Large scale priority decisions regarding the adoption of specific numeric nutrient criteria for Kansas waters may follow.

Recommendation #14: Improve laboratory communication and services

Water quality data generated by the department's Kansas Health and Environmental Laboratory (KHEL) are applied in the derivation of permit limits for discharging wastewater treatment facilities, in the formulation of goals and objectives for the abatement of non-point source pollution, in the development and implementation of TMDLs, and in many other routine departmental operations. The department's weekly water sampling activities in support of its objectives and goals allows for frequent interactions between analytical staff and monitoring/assessment personnel. Current protocols for transferring and logging samples have been optimized over a period of many years and are carefully tailored to the existing laboratory arrangement. To strengthen the foundation of the department's environmental monitoring operations, an annual planning meeting between management in the department and the laboratory is recommended to improve communication and collaboration to build and support relationships. The annual planning meetings would ensure continuity between the department's monitoring goals and objectives and the laboratory's future directions, and help identify immediate and long-range challenges and resource needs. More recently, the KHEL has been analyzing microcystin concentrations for public water supply lakes associated with HAB responses. It is recommended to continue to explore ways to expand upon testing for toxins, through qPCR or advance approaches, to provide additional analyses associated with public health protection. Additionally, it is recommended to revisit reporting limits for specific parameters that have elevated in interest and priority due to current program functions, initially starting with the improvement and lowering of the ortho-phosphate reporting limit.

Recommendation #15: Reinstate groundwater quality monitoring program

Given the overall importance of groundwater to the societal and ecological well-being of Kansas, the department should evaluate the need and feasibility to resume ambient (aquifer-based) groundwater quality monitoring operations. The legacy groundwater quality database, associated metadata, and related quality assurance documentation (KDHE 2000b) should provide the information needed by the department to recommence groundwater monitoring operations with minimal developmental cost and delay. However, prior to doing so it is recommended to conduct a thorough evaluation of the current groundwater monitoring efforts being conducted throughout the state and collaborate with participating agencies (*i.e.* KGS, USGS, GMDs) to establish an

understanding of whether there are critical groundwater data gaps that may support the need to reestablish groundwater monitoring operations within the department. This information is generally compiled every two years with the development of the Integrated Water Quality Assessment report. Based on historical expenditures and inflationary considerations, an annual budgetary allocation of about $300,000 would likely be needed to fully restore this program. Alternatively, it is additionally recommended to consider establishing a smaller network of selected sentinel wells that can serve to monitor changes in groundwater quality over time. Prioritizing certain areas also may be justified if there is a lack of information in specific areas. For example, groundwater monitoring in some locations might indicate poor quality water infiltrating from the surface water into the aquifer (*e.q.* Arkansas River (TDS, SO4, Se, or U), Rattlesnake Creek (Cl), or Equus Beds (Cl)). It is recommended to complete a feasibility study to restore the groundwater monitoring program and identify the scope of the program restoration if warranted. If the program is restored in any capacity, costs may be off-set with cooperative agreements with the EPA Region 7 laboratory for analytical assistance and/or with BEFS district staff to assist with monitoring activities.

Recommendation #16: Missouri River stream monitoring

Logistical constraints have prevented the department from routinely monitoring the condition of the Missouri River, the largest stream bordering Kansas. It is recommended that the department defer monitoring of the Missouri River until an interstate agreement can be negotiated between EPA Region 7 and the states within the region. Until an agreement is reached, collaborate with Region 7 on related issues.

Priority of Recommendations and estimated timeline.

Priority	Recommendation	Task	Priority Task Description	Timeline	Target Date for Completion
1	Harmful Algal Bloom cyanobacteria cell count alternatives	1a	Identify new method to estimate cell counts	2019-2021	2021
2	Subwatershed monitoring expansion and amendment	2a	Alternate flow measurements	2019	2022
		2b	Redefine program objectives, site selection and monitoring frequency	2020-2022	
3	Enhance Stream Probabilisitic	3a	Evaluate enhancements and report on first ten years of program	2020-2021	2022
		3b	Implement program enhancements	2022-2024	2024
4	Refine ALUS Index and conduct mussel survey	4a	Establish workgroup and refine ALUS index	2019-2024	2024
		4b	Conduct Mussel Survey	2021-2022	2023
5	Improve transparency of surface WQ data	5a	Update and improve WQ atlas	2019-2021	2021
6	Update the Kansas Surface Water Register	6a	Complete initial updates with Triennial Review	2019-2020	2021
7	Compliance Monitoring Enhancements	7a	Enhace program sampling plan	2020-2021	2021
		7b	Implement enhancements	2022	2022
8	TMDL effectiveness planning, monitoring and assessment	8a	Develop monitoring plan and strategy	2023-2026	2026
		8b	50 year water quality assessment	2021-2023	2023
9	Improve Water Quality Data management	9a	Evaluate Oracle alternatives	2020-2025	2026
		9b	Replace PALM equipment	2019-2021	2021
10	Resume bacteriological monitoring	10a	Establish bacteria monitoring plan	2020-2023	2023
		10b	Resume intensive monitoring	2024-2027	2027
11	Provide Additional Monitoring and Assessment training	11a	Cross training	2019-2026	
12	Assess feasibility for additional parameters	12a	Collaborate with KHEL	2020-2027	2027
		12b	Collaborate with EPA R7	2020-2027	2027
13	Improve capacity for data interpretation	13a	Add capacity for data projects	2020-2026	
		13b	Evaluate best lakes in KS	2019-2020	2020
		13c	Numeric nutrient criteria	2025-2028	2028
14	Improve Laboratory Communication and services	14a	Initiate coordination meeting	2019	2019
		14b	toxin testing method exploration	2019-2021	
		14c	revisit reporting limits	2020	2020
15	Reinstate groundwater quality monitoring program	15a	Evaluate existing groundwater monitoring efforts	2022-2024	2025
		15b	Complete feasibility study to restore program in some capacity	2024-2026	2027
16	Missouri River monitoring	16a	Collaborate with R7	2020-2027	2027

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APPENDIX A

Major Federal and State Statutes and Regulations
Addressing Water Quality Monitoring and Assessment

Clean Water Act

Section 104(a): The [EPA] Administrator shall establish national programs for the prevention, reduction, and elimination of pollution and as part of such programs shall…in cooperation with the States, and their political subdivisions, and other Federal agencies establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters and ground waters…

Section 106(e): [The] Administrator shall not make any grant under this section to any State which has not provided or is not carrying out as part of its program…the establishment and operation of appropriate devices, methods, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition), the quality of navigable waters and to the extent practicable, ground waters including biological monitoring; and provision for annually updating such data and including it in the report required under section 305 of this Act…

Section 303(d): Each State shall identify those waters within its boundaries for which the effluent limitations required by section 301(b)(1)(A) and section 301(b)(1)(B) are not stringent enough to implement any water quality standard applicable to such waters. The State shall establish a priority ranking for such waters, taking into account the severity of the pollution and the uses to be made of such waters.

Section 305(b): Each State shall prepare and submit to the Administrator…a [biennial] report which shall include…(A) a description of the water quality of all navigable waters in such State…; (B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water; (C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows for recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to the additional action necessary to achieve such objectives and for what waters such additional action is necessary…; (E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources…

Section 314(a): Each State on a biennial basis shall prepare and submit to the Administrator for his approval…an identification and classification according to eutrophic condition of all publicly owned lakes in such State…a list and description of those publicly owned lakes in such State for which uses are known to be impaired…[and] an assessment of the status and trends of water quality in lakes in such State, including but not limited to, the nature and extent of pollution

loading from point and nonpoint sources and the extent to which the use of lakes is impaired as a result of such pollution, particularly with respect to toxic pollution.

Section 319(h): Each State shall report to the Administrator on an annual basis concerning…to the extent that appropriate information is available, reductions in nonpoint source pollution loading and improvements in water quality for those navigable waters or watersheds within the State…resulting from implementation of the [nonpoint source pollution control] program.

Code of Federal Regulations

40 CFR 35.168(a): The Regional Administrator may award section 106 funds to a State only if…the State monitors and compiles, analyzes, and reports water quality data as described in section 106(e)(1) of the Clean Water Act…

40 CFR 123.26(b): State programs shall have inspection and surveillance procedures to determine, independent of information supplied by regulated persons, compliance or noncompliance with applicable program requirement. The State shall implement and maintain…a program for periodic inspections of the facilities and activities subject to regulation. These inspections shall be conducted in a manner designed to:

(i) Determine compliance or noncompliance with issued permit conditions and other program requirements;
(ii) Verify the accuracy of information submitted by permittees and other regulated persons in reporting forms and other forms supplying monitoring data; and
(iii) Verify the adequacy of sampling, monitoring, and other methods used by permittees and other regulated persons to develop that information…

40 CFR 130.4(a): In accordance with section 106(e)(1), States must establish appropriate monitoring methods and procedures (including biological monitoring) necessary to compile and analyze data on the quality of the waters of the United States and, to the extent practicable, ground-waters…

40 CFR 130.4(b): The State's water monitoring program shall include collection and analysis of physical, chemical and biological data and quality assurance and control programs to assure scientifically valid data. The uses of these data include determining abatement and control priorities; developing and reviewing water quality standards, total maximum daily loads, wasteload allocations and load allocations; assessing compliance with National Pollutant Discharge Elimination System (NPDES) permits by dischargers; reporting information to the public through the section 305(b) report and reviewing site-specific monitoring efforts.

40 CFR 130.6(c)(9): Identification and development of programs for control of ground-water pollution including the provisions of section 208(b)(2)(K) of the Act. States are not required to develop ground-water WQM plan elements beyond the requirements of section 208(b)(2)(K) of the Act, but may develop a ground-water plan element if they determine it is necessary to address ground-water quality problem. If a State chooses to develop a ground-water plan element, it should describe the essentials of a State program…[including] monitoring and resource assessment programs in accordance with section 106(e)(1) of the Act.

Kansas Statutes Annotated

K.S.A. 65-161a: "Waters of the state" means all streams and springs, and all bodies of surface and subsurface water within the boundaries of the state…

K.S.A. 65-170: For the purpose of carrying out the provisions of this act it shall be the duty of the director of the division of environment to investigate and report upon all matters relating to water supply and sewerage and the pollution of the waters of the state that may come before the secretary of health and environment for investigation or action, and to make such recommendations in relation thereto as the director may deem wise and proper, and to make such special investigations in relation to methods of sewage disposal and public water supply and the purification of water as may be necessary in order to make proper recommendations in regard thereto, or as may be required by the secretary of health and environment.

K.S.A. 65-170b: In performing investigations or administrative functions relating to water pollution or a public water supply system…the secretary of health and environment or the secretary's duly authorized representatives upon presenting appropriate credentials, may enter any property or facility which is subject to the provisions of [this act], or any amendments thereto, for the purpose of observing, monitoring, collecting samples, examining records and facilities to determine compliance or noncompliance with state laws and rules and regulations relating to water pollution or public water supply.

The secretary of health and environment or the secretary's duly authorized representative shall make such requirements as they deem necessary relating to the inspection, monitoring, recording, and reporting by any holder of sewage discharge permit…or any holder of a public water supply system permit…

K.S.A. 65-171a: The authority of the secretary of health and environment in matters of stream pollution is hereby supplemented to include stream pollution found to be detrimental to public health or detrimental to the animal or aquatic life of the state.

K.S.A. 65-171d(c): For the purposes of this act…and any amendments thereto, pollution means: (1) Such contamination or other alteration of the physical, chemical or biological properties of any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, or to the plant, animal or aquatic life of the state or to other designated beneficial uses; or (2) such discharge as will or is likely to exceed state effluent standards predicated upon technologically based effluent limitations.

APPENDIX B

Core and Supplemental Physiochemical Parameters: KDHE Surface Water and Fish Tissue Monitoring Programs

Stream Chemistry and Stream Probabilistic Monitoring Programs

Core Composite and Inorganic Parameters

Alkalinity, total (as $CaCO_3$)
Aluminum, total recoverable
Ammonia, total (as N)
Antimony, total recoverable
Arsenic, total recoverable
Barium, total recoverable
Beryllium, total recoverable
Boron, total recoverable
Bromide
Cadmium, total recoverable
Calcium, total recoverable
Carbon, total organic
Chloride
Chromium, total recoverable
Cobalt, total recoverable
Copper, total recoverable
Dissolved oxygen
Fluoride
Hardness, total (as $CaCO_3$)
Iron, total recoverable
Kjeldahl nitrogen
Lead, total recoverable
Magnesium, total recoverable
Manganese, total recoverable
Mercury, total
Molybdenum, total recoverable
Nickel, total recoverable
Nitrate (as N)
Nitrite (as N)
pH (field)
Phosphate, ortho- (as P)
Phosphorus, total (as P)
Potassium, total recoverable
Selenium, total recoverable
Silica, total recoverable (as SiO_2)
Silver, total recoverable
Sodium, total recoverable
Specific conductance
Strontium, total recoverable
Sulfate
Thallium, total recoverable
Total dissolved solids (calculated)
Total suspended solids
Turbidity
Vanadium, total recoverable
Zinc, total recoverable
Temperature (field)

Core Organic Parameters

Acetochlor
Alachlor
Aldrin
Atrazine (Aatrex)
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Butachlor
Carbofuran (Furadan)
Chlordane
Cyanazine (Bladex)
DCPA (Dacthal)
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Methoxychlor
Metolachlor (Dual)
Metribuzin (Sencor)
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
Propachlor (Ramrod)
Propazine (Milogard)
Simazine
Toxaphene

Routine Microbiological Parameters

Escherichia coli bacteria

Supplemental Organic Parameters

Chlorophyll-a
Chlorpyrifos (Dursban)
Deethylatrazine
Desethylated atrazine
Diazinon
Pentachlorophenol
Pheophytin-a
Prometon (Pramitol)

Supplemental Radiological Parameters

Actinium-228
Americium-241
Antimony-125
Barium-140
Beryllium-7
Cerium-141
Cerium-144
Cesium-134
Cesium-136
Cesium-137
Chromium-51
Cobalt-57
Cobalt-58
Cobalt-60
Gallium-67
Gross alpha
Gross beta
Gross uranium
Indium-111
Iodine-123
Iodine-131
Iodine-132
Iodine-133
Iron-59
Lanthanum-140
Lead-212
Lead-214
Manganese-54
Molybdenum-99
Neodymium-147
Neptunium-239
Niobium-95
Potassium-40
Radium-226
Radium-228
Ruthenium-103
Ruthenium-106
Silver-110m
Technetium-99m
Thorium-228
Total Solid
Tritium
Ytterbium-169
Zinc-65
Zirconium-95

Lake and Wetland Water Quality Monitoring Program

Core Composite and Inorganic Parameters

Core Organic Parameters

Acetochlor
Alachlor
Aldrin
Atrazine (Aatrex)
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
Butachlor
Carbofuran (Furadan)
Chlordane
Chloropyll-a
Cyanazine (Bladex)
DCPA (Dacthal)
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Methoxychlor
Metolachlor (Dual)
Metribuzin (Sencor)
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
Pheophytin-a
Picloram (Tordon)
Propachlor (Ramrod)
Propazine (Milogard)
Simazine
Toxaphene
2,4-D as acid
2,4,5-T as acid (Silvex)

Supplemental Parameters

Microcystins
Perchlorate

Fish Tissue Contaminant Monitoring Program

Core Organic and Inorganic Parameters

gamma-BHC (Lindane)
Cadmium
Chlordane, technical
cis-Chlordane
trans-Chlordane
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Lead
Mercury
Mirex
cis-Nonachlor
trans-Nonachlor
Oxychlordane
PCB-1248
PCB-1254
PCB-1260
Pentachloroanisole
Pentachlorobenzene
Selenium
1,2,4,5-Tetrachlorobenzene
Trifluralin (Treflan)

Supplemental Organic and Inorganic Parameters

Acenaphthene
Acenaphthylene
Acrolein
Acrylonitrile
Alachlor (Lasso)
Aldrin
Aluminum
Aniline
Anthracene
Antimony
Aroclor-1248
Aroclor-1254
Aroclor-1260
Arsenic
Atrazine (Aatrex)
Azinphosmethyl (Guthion)
Barium
Benzene
Benzidine
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzoic acid
Benzo(g,h,i)perylene
Benzo(a)pyrene
Benzylalcohol
Beryllium
alpha-BHC
beta-BHC
delta-BHC
Bromoform
4-Bromophenyl phenyl ether
Butylbenzylphthalate
Calcium
Carbon tetrachloride
Chlorobenzene
Chlordene
alpha-Chlordene
beta-Chlordene
gamma-Chlordene
Chlorodibromomethane
Chloroethane
bis(2-Chloroethoxy)methane
4-Chloroethoxy phenyl ether
bis(2-Chloroethyl)ether
2-Chloroethyl vinyl ether
Chloroform
bis(2-Chloroisopropyl)ether
p-Chloro-m-cresol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chlorpyrifos (Dursban)
Chromium
Chrysene
Cobalt
Copper
Demeton (Systox)
Dibenzo(a,h)anthracene
o,p'-DDE
o,p'-DDD
o,p'-DDT
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3-Dichlorobenzidine
Dichlorobromomethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,1-Dichloroethylene
1,2,-trans-Dichloroethylene
2,4-Dichlorophenol
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Diethylphthalate
2,4-Dimethylphenol
Dimethylphthalate
Di-n-butylphthalate
4,6-Dinitro-o-cresol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphthalate
1,2-Diphenylhydrazine
alpha-Endosulfan
beta-Endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Ethylbenzene
bis(2-Ethylhexyl)phthalate
Ethyl parathion
Fluorene
Fluoranthene
Fonofos (Dyfonate)
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
Hexachlorobutadiene
Hexachlorocyclopentadiene
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
Hexachloroethane
Indeno(1,2,3-c,d)pyrene
Iron
Isophorone
Lipids, total (%)
Malathion
Manganese
Magnesium
Methoxychlor
Methyl bromide
Methyl chloride
Methylene chloride
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Metolachlor
Metribuzin (Sencor)
Molybdenum
Naphthalene
Nickel
2-Nitroanaline
3-Nitroanaline
4-Nitroanaline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodi-n-propylamine
N-Nitrosodiphenylamine
PCB-1016
PCB-1221
PCB-1232
PCB-1242
Penoxalin (Prowl)
Pentachloroanisole
1,2,3,7,8-Pentachlorodibenzo-p-dioxin
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
Pentachlorophenol
cis-Permethrin
trans-Permethrin
Phenanthrene
Phenol
Potassium
Prometon (Pramitol)
Propazine (Milogard)
Pyrene
Simazine (Princep)
Silver
Sodium
Styrene
2,3,7,8-Tetrachlorodibenzo-p-dioxin
2,3,7,8-Tetrachlorodibenzofuran
1,1,2,2-Tetrachloroethane
1,1,2,2-Tetrachloroethene
Tetrachloroethylene
Thallium
Titanium
Toluene
Toxaphene
1,2,4-Trichlorobenzene
Trichloroethane
Trichloroethylene
Trichlorfon (Dylox)
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Vanadium
Vinyl chloride
Zinc